Vol. 32 July, 1938 No. 1

QUARTERLY

OF THE

National Fire Protection Association

Subscriptions to the QUARTERLY are accepted only as a part of the general publications of the Association which are sent to members. Associate membership is open to anyone interested; annual dues $10.

Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879.

60 BATTERYMARCH STREET, BOSTON, MASS.

National Fire Protection Association

INTERNATIONAL

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Western Canada Insurance Underwriters' Association.
Western Factory Insurance Association.
Western Sprinkled Risk Association.
Western Underwriters Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.

Printed in U. S. A.

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Acme.

Thirty-five persons lost their lives in this fire (the worst hotel fire tragedy in the United States in 40 years), which destroyed the 5-story brick joisted Terminal Hotel in Atlanta, Ga., early on the morning of May 16, 1938. The building code in effect in 1908 when this building was erected did not permit a building of this construction and occupancy over four stories high, but this building was exempted from the code provision by a special ordinance. When the first firemen arrived, flames were pouring from upper windows and guests were jumping to the street. The stairs and elevator were cut off by fire. There were no automatic sprinkler or automatic fire alarm systems to offset firetrap conditions. (See report, page 46.)

The Quarterly

Vol. 32 July, 1938 No. 1

The 42nd Annual Meeting. The Proceedings of the 42nd annual meeting of the Association, published as Part II of this QUARTERLY, furnish an impressive exhibit of the activity and progress of the Association during the past year. This annual meeting, like its predecessors, was replete with interesting technical and educational developments. Every year brings to our meetings a new group of men who enthusiastically join our older members in carrying forward the important work of the Association. New problems in fire prevention and fire protection every year challenge us for an effective solution. It is also interesting to note that even the subjects which have received the greatest amount of attention in past years still call for active attention to keep our recommendations always up to date. The rules for automatic sprinkler installations were the first N.F.P.A. standard. The initial work in the evolution of these regulations, in fact, antedated the formal organization of the N.F.P.A.; the formation of the Association was largely stimulated by the need to have a properly constituted permanent body to sponsor these and other related regulations. At the annual meeting in May the Committee on Automatic Sprinklers presented a comprehensive report, and some of the technical details of sprinkler protection occasioned extended discussion. As our annual meetings roll by year after year, it appears that no division of the Association's work is ever really finished and that we must give continuous attention to all matters of fire prevention and fire protection, old and new, in order to maintain our effectiveness and give dynamic impulse to the continuing campaign for the reduction of loss of life and property by fire.

* * * * *

Educating the New Generation. Fire protection, while technical in many of its aspects, rests fundamentally upon public education; it is only when the importance of the subject is recognized that the necessary impetus is given for the application of technical measures of fire prevention and fire protection. Public education, or even education of a very limited group, must be continuous to be effective. A given group of employees in some hazardous industry may be fully informed as to the importance of fire-safety measures, with resultant notable decrease in fire losses, but as a new generation comes into the industry educational activities must be maintained

in order to retain the improved record. A striking example of this is furnished in the field of dust explosion prevention. Dr. David J. Price of the U. S. Department of Agriculture, Chairman of the N.F.P.A. Committee on Dust Explosion Hazards, at the annual meeting in May analyzed some of the recent dust explosions in industrial plants, which are described in further detail in the article by Dr. Price and his associates appearing in this issue of the QUARTERLY. Research studies on the prevention of dust explosions in both industrial plants and in coal mines have been going on now for more than twenty-five years. During the World War period, when grain dust explosions threatened to have a serious effect in reducing available food supplies, an intensive educational campaign was conducted throughout the country in grain elevators, flour mills and similar plants where a dust explosion hazard was present. After all this activity it would appear reasonable to expect that officials and employees in industrial plants where explosive dusts are produced would be fully informed as to the hazards of dust explosions and the methods that should be employed for their prevention or control. However, the investigation of the series of explosions during March and April this year has definitely indicated that many of the younger employees in these plants have not had occasion to become familiar with the dust explosion hazard and that the educational work carried on twenty years ago must be resumed with the oncoming generation.

* * * * *

Testing for Fire Prevention. It is an axiom of fire protection that no form of mechanical or electrical equipment, no matter how well made and carefully installed, can be expected to continue indefinitely in proper operating condition unless it receives regular maintenance service. Automatic sprinkler systems and other extinguishing facilities are regularly tested to detect any defects which require attention to prevent impairment of protection. Fire alarm systems are continuously supervised through electrical devices which give an immediate trouble signal when any defect appears.

In the field of fire prevention, on the other hand, inspections are commonly limited to visual examination of points of possible fire hazard. Visual examination is all that is needed in respect to most common fire hazards, but there are many hazards which are not obvious, and where it is impossible to determine, without engineering tests, whether equipment is in safe operating condition. The article by Mr. Duggan in this QUARTERLY describes an interesting testing program for the prevention of fires and explosions, designed to keep equipment for flammable liquids and gases at all times in such condition that no unseen defects may permit the escape of flammable materials with resultant fires or explosions. The general application of this idea, in place of the present all too common practice of making a good initial installation but continuing equipment in service until it deteriorates to the point of actual

failure, would be a major advance in the practice of fire prevention. It may be hoped that this idea will spread, and that in time we may look forward to the development of standardized techniques for the periodic retesting of every type of equipment whose failure may be the cause of fire.

* * * * *

Loss of Life Statistics. The interesting article describing twenty years of fatal fires in San Francisco by Member Clarence Heller displaces in this issue of the QUARTERLY the usual three months' tabulation of fires in which there was loss of life. This feature, however, will reappear in the October issue with a six months' record. Mr. Heller's thoughtful analysis of the fundamental factors involved in loss of life by fire in San Francisco reflects the sort of detailed attention and analysis which might well be applied to the fire problem of every city. Records are regularly compiled of property losses by fire in most cities, but loss of life and personal injury by fire seldom receive detailed attention in fire department annual reports. Records are often kept of the fire casualties in important fires, but these have only limited public significance unless analyzed with respect to the various features of building construction, control of hazards and fire protection, which are covered in building codes and other municipal legislation. Furthermore, these statistics are not complete unless they include deaths by fire occurring when the fire does not involve a building and the fire department is not called, and the various indirect fire casualties which are commonly not reported to the fire department. The whole subject of fire casualty statistics deserves much further consideration than it has had from the national and state or provincial point of view as well as from the point of view of the individual city. It is hoped that Mr. Heller's analysis of the San Francisco situation may stimulate further attention to this important matter in other quarters.

Meetings of Board of Directors.

Atlantic City, May 9, 1938.

Present.

Albert T. Bell, Chairman
George W. Elliott, President
S. D. McComb, Vice-President
A. R. Small, Vice-President
Harold L. Miner, Past President
Sumner Rhoades, Past President
Franklin H. Wentworth, Managing Director

Eugene Arms
A. O. Dawson
Hovey T. Freeman
C. W. Johnson
A. H. Kehoe
F. T. Moses
S. L. Nicholson
D. J. Price
D. V. Stroop
Richard E. Vernor
John L. Wilds

There was present, as a guest, Mr. A. L. Brown, Chief Engineer, Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston.

Business Transacted.

1. The procedure of the Executive Office respecting the presentation of the report of the Committee on Manufacturing Hazards on Lacquer Manufacturing Plants was approved.

2. Comments from members of Committee on Articles of Association following their consideration as requested by the Board of Article 7 governing the Nominating Committee were considered without action.

3. The recommendation of the Executive Office concerning special handling of the organization membership of the Bureau of Explosives of the American Railway Association was approved.

4. Report by the Managing Director for the Advisory Committee, on proposed withdrawal by American Standards Association of N.F.P.A. proprietary sponsorship for Regulations Governing Blower and Exhaust Systems, was discussed without action.

5. Report of the Treasurer was approved.

6. Report of Chairman of the Board was approved.

7. Date of summer meeting of the Board was set for Monday, June 20, in Boston.

Boston, June 20, 1938.

Present.

Albert T. Bell, Chairman
Samuel D. McComb, President
David J. Price, Vice-President
A. R. Small, Vice-President
George W. Elliott, Past President
Harold L. Miner, Past President
Franklin H. Wentworth, Managing Director

H. T. Cartlidge
A. O. Dawson
Frank A. Epps
Hovey T. Freeman
Russell Grinnell
C. W. Johnson
Arthur H. Kehoe
W. E. Mallalieu
Frederick T. Moses
S. L. Nicholson
C. W. Pierce
H. Sidney Smith

There were also present Percy Bugbee, Assistant Managing Director, and Robert S. Moulton, Technical Secretary.

Business Transacted.

1. The following members were elected officers of the corporation for the year 1938-1939: President, Samuel D. McComb; Vice-President, A. R. Small; Vice-President, David J. Price; Secretary-Treasurer and Managing Director, Franklin H. Wentworth; Chairman, Board of Directors, Albert T. Bell.

2. The Advisory Committee for 1938-1939 was appointed to consist of Albert T. Bell, Chairman, Samuel D. McComb, A. R. Small, D. J. Price, and C. W. Pierce.

3. Messrs. C. W. Pierce and Russell Grinnell were selected to complete the Nominating Committee for 1939.

4. It was voted to hold the 43rd annual meeting in Chicago during the week of May 8, 1939.

5. The following Program Committee was appointed: the President, the Chairman of the Board of Directors, and the Managing Director, with authority to add to their number.

6. It was voted to refer to a special committee to be appointed by the Chair a proposal by Managing Director Wentworth that his status be changed to that of Consulting Director during the year 1939-1940. The Chair appointed the following committee: George W. Elliott, Chairman, Samuel D. McComb and Albert T. Bell, ex-officio.

7. The relations of the N.F.P.A. with the American Standards Association were discussed with particular reference to the action of the A.S.A. with respect to the N.F.P.A. sponsorship of the Regulations on Air Conditioning and on Blower and Exhaust Systems. It was voted that a special committee of five members be appointed by the Chair to confer with appropriate representatives of the A.S.A. to seek a solution of the problems in connection with our joint relations and to report to the Board. The Chair appointed the following committee: George W. Elliott, Chairman, H. T. Cartlidge, Hovey T. Freeman, Russell Grinnell, A. R. Small.

8. The budget submitted by the Treasurer was approved subject to reference of certain proposed salary increases to the Finance Committee with power.

9. A resolution of the Board was adopted expressing appreciation of Mr. Rainey's conscientious and devoted service as Chairman of the Membership Committee.

10. Communications from the Committee on Field Practice and from Chief Engineer George W. Booth of the National Board of Fire Underwriters on the use of the word "approved" in the Regulations on First Aid Fire Appliances were considered without action.

11. The recommendation for the appointment of additional members to the Special Committee for Drafting an Electrical Law made to the Board by the annual meeting was discussed and referred to the President with power.

12. A proposal for the appointment of a Committee on Fire Protection Engineering Education was discussed and referred to the Executive Office for development of a program and personnel for this committee and report at the next meeting of the Board.

Technical Committee Items.

13 (a). After consideration of several communications pertaining thereto, amendments to the Regulations for the Installation of Air Conditioning, Warm Air Heating, Air Cooling and Ventilating Systems prepared by the Committee on Blower Systems and referred to the Board by the annual meeting were adopted (text of these amendments will be found in the 1938 Proceedings) with the following rewording of the revised second and third sentences of Rule 151 recommended by the Chairman of the committee.

"The installation of approved automatic extinguishing equipment employing water, gas or other suitable means is recommended in the enclosure of the air conditioning systems to protect against combustion of material that may accumulate, except that protection is not required in the unit or cabinet type of air conditioning equipment with blower capacity not exceeding 20,000 C.F.M. and where the unit supplies only one floor area or a portion thereof. Where sprinklers are installed, suitable provision should be made for drainage."

13 (b). A report on the Regulation of Trailers While Not in Transit, submitted by the Committee on City Planning and Zoning with the concurrence of the Committee on Trailers and Trailer Camps (the text will be found in the report of the Committee on City Planning and Zoning in the 1938 Proceedings), referred to the Board by the annual meeting, was adopted with the following amendments submitted by the Secretary of the Committee on City Planning and Zoning and revised by the Board.

Add the following definition:

"The term 'trailer camp' shall be construed to refer to any premises where more than one house trailer is parked for living or sleeping purposes, or any premises used or held out for the purpose of supplying to the public a parking space for more than one house trailer for living or sleeping purposes."

Add the word "house" before the word "trailer" or "trailers" in the second line of Division A, in the first line of paragraph (3) of Division B, and in the first three lines of Division C.

Add to the paragraph under Division A the following definitions: "The term 'house trailer' shall be construed to refer to any structure used or designed to be used for living or sleeping purposes, mounted on wheels and propelled by its own power or by a power-driven vehicle to which it is attached."

Division B, paragraph (2) d: Add the following: "; in either case supplemented by an adequate supply of such first aid hand fire extinguishers suitable for use on flammable liquid fires as may be required by the size of the camp."

13 (c). Editorial changes in the Regulations on First Aid Fire Appliances and on Standpipe and Hose Systems submitted by the Committee on Field Practice in accordance with the authorization of the annual meeting were approved.

Note: The complete revised texts incorporating these changes will in due course be circulated to all N.F.P.A. members.

13 (d). A report from the Committee on Gases was presented, to the effect that the committee was not as yet ready to report on changes in the regulations on liquefied petroleum gases which were referred to the committee by the annual meeting with authority to report to the Board with power. In view of a reported need for prompt promulgation of such amendments on completion by the committee, it was voted to refer such amendments to the Committee on Technical Committee Procedure with authority to act in the name of the Board.

14. The report of the Committee on Technical Committee Procedure was approved, including action on the following recommendations of the committee:

Authorization to act on matters of committee personnel prior to publication of the 1938 Year Book, subject to confirmation by the Board.

Approval of the recommendation that no present action be taken on a proposal from the National Electrical Manufacturers Association that a representative of that association be appointed to the Committee on Trailers and Trailer Camps.

Approval of the proposal that an invitation be extended to the American Society of Heating and Ventilating Engineers to nominate a representative to the Committee on Blower Systems.

Rescinding the statement of policy in respect to N.F.P.A. committee appointments recommended by the Committee on Technical Committee Procedure and approved by the Board at its meeting June 21, 1937 (QUARTERLY, July, 1937, page 13, item 20, second fine print paragraph) because of the view of the Committee on Technical Committee Procedure that this statement has during the past year hampered the committee in securing desirable technical committee members and the view that each case should be considered on its individual merits.

Authorization to the Committee on Gases to proceed with the development of a report on the use of liquefied petroleum gas in small municipal gas systems.

15. The list of proposed technical committee appointments recommended by the Committee on Technical Committee Procedure was confirmed. President McComb was authorized to revise the Membership Committee in accordance with the recommendations of Chairman Rainey. (The revised personnel of the committee will be shown in the 1938 Year Book.)

The 1937 Fire Loss.

Fire losses in the United States for the year 1937 as estimated by the National Board of Fire Underwriters were $253,859,796. This is a decrease of about $13,000,000, or about five per cent, from the 1936 loss. The following table gives the annual fire loss in the United States for the past sixty-three years. The second table shows a comparison of per capita losses for the whole country with cities of 20,000 population or over for the past ten years.

Annual Fire Losses in the United States for Sixty-Three Years.

Year	Property Loss	Year	Property Loss	Year	Property Loss
1875.....	$78,102,285	1896.....	$118,737,420	1917.....	$289,535,050
1876.....	64,630,600	1897.....	116,354,575	1918.....	353,878,876
1877.....	68,265,800	1898.....	130,593,905	1919.....	320,540,399
1878.....	64,315,900	1899.....	153,597,830	1920.....	447,886,677
1879.....	77,703,700	1900.....	160,929,805	1921.....	495,406,012
1880.....	74,643,400	1901.....	165,817,810	1922.....	506,541,001
1881.....	81,280,900	1902.....	161,078,040	1923.....	535,372,782
1882.....	84,505,024	1903.....	145,302,155	1924.....	549,062,124
1883.....	100,149,228	1904.....	229,198,050	1925.....	559,418,184
1884.....	110,008,611	1905.....	165,221,650	1926.....	561,980,751
1885.....	102,818,796	1906.....	518,611,800	1927.....	472,933,969
1886.....	104,924,750	1907.....	215,084,709	1928.....	464,607,102
1887.....	120,283,055	1908.....	217,885,850	1929.....	459,445,778
1888.....	110,885,665	1909.....	188,705,150	1930.....	501,980,624
1889.....	123,046,833	1910.....	214,003,300	1931.....	451,643,866
1890.....	108,993,792	1911.....	217,004,575	1932.....	400,859,554
1891.....	143,764,967	1912.....	206,438,900	1933.....	271,453,189
1892.....	151,516,098	1913.....	203,763,550	1934.....	271,197,296
1893.....	167,544,370	1914.....	221,439,350	1935.....	235,263,401
1894.....	140,006,484	1915.....	172,033,200	1936.....	266,659,449
1895.....	142,110,233	1916.....	258,377,952	1937.....	253,859,796

NOTE:—Previous to 1916 figures obtained from the records of the New York *Journal of Commerce*, deducting the Canadian losses. Subsequent years are based on returns to the Actuarial Bureau of the National Board of Fire Underwriters, adding 25% for unreported and uninsured losses. Since 1935, 30% has been added for unreported losses. The figure for 1937 is based on estimates made by the Actuarial Bureau.

Comparative U. S. Fire Losses.

	Whole Country			Cities of 20,000 Population and Over		
	Population	Total Loss	Per Capita	Population	Total Loss	Per Capita
1928.....	120,013,000	$464,607,102*	$3.87	51,836,000	$140,038,116†	$2.70
1929.....	120,700,000	459,445,778	3.81	53,411,000	145,059,043	2.72
1930.....	122,775,046	501,980,624	4.09	50,206,000	150,981,223	3.01
1931.....	124,070,000	451,643,866	3.64	51,084,000	125,933,681	2.47
1932.....	124,822,000	400,859,554	3.21	51,295,000	113,947,789	2.22
1933.....	125,693,000	271,453,189	2.16	51,553,000	77,686,291	1.51
1934.....	126,425,000	262,848,122	2.08	51,179,000	82,770,881	1.59
1935.....	127,520,000	235,263,401	1.85	53,184,000	69,720,824	1.33
1936.....	128,429,000	266,659,449	2.08	53,802,000	75,390,886	1.40
1937.....	129,257,000	253,859,796	1.96	53,943,000	79,615,000	1.48

*Estimated from Records of the Actuarial Bureau. †Figures reported by fire departments.

Losses in Cities of 20,000 Population or Over.

Losses in cities of 20,000 population and over as reported by fire departments show an increase in 1937 of about six per cent over 1936, while in the country as a whole there was a decrease. There was no change in the average per capita fire loss for all cities of 100,000 population or over—being $1.42 for both 1936 and 1937, but for the fourteen cities of over 500,000 population there was a decrease of 13 per cent, and for the seventeen cities of 300,000 to 500,000 population there was an increase of 11 per cent. The 1937 per capita fire loss for the country as a whole was $1.96, as compared with $1.48 average for the 488 cities of 20,000 population or over.

The per capita fire loss statistics of cities over 100,000 population published in the following tables are again presented as the best available criterion for the comparison of fire experience of cities in the same population class. The figures for 1937 have been compiled from reports of fire departments or other municipal agencies in the various cities. The figures for previous years are those obtained from similar sources by the National Board of Fire Underwriters and published in the July QUARTERLY a year ago. Computation of the per capita figures involves some difficulty, as the latest U. S. Census Bureau figures are dated 1933 and many population changes have occurred since; in the absence of official population figures, the 1937 computations have been made in most instances on the basis of the same population estimates as were used in 1936.

These per capita statistics based upon fire department reports unmodified by subsequent underwriters' adjustments are accepted as but approximately accurate. They are utilized to indicate general fire experience and not for purposes of specific comparisons between cities, even of like population, in respect of the value or efficiency of municipal agencies of fire safety or fire defense.

Fire losses, nevertheless, are the composite results of the character of a city's population, the nature of its building construction as influenced by the building code, the sort of legislation controlling its fire hazards, the adequacy of its water supplies and other fire protection facilities, and the efficiency of its fire department. These agencies are measurably comparable, and fire losses expressed in per capita figures attract the attention of citizens, stimulate investigation of fire causes and make for collective interest in improved fire defense. The major value of such tables is to illustrate the trend of fire losses in an individual city in terms the ordinary citizen can understand.

At the end of the tables showing per capita losses in cities over 100,000 population there are additional tables showing the cities of 20,000 population or over which had losses exceeding five dollars per capita and those with less than twenty-five cents per capita in 1937.

Per Capita Fire Losses of Cities Over 500,000 Population.

	Population	1933	1934	1935	1936	1937	Five-Year Average
New York, N. Y.	7,364,000	$1.32	$1.26	$1.15	$1.05	$ .81	$1.12
Chicago, Ill.	3,475,000	1.64	3.18	1.07	1.78	1.42	1.82
Philadelphia, Pa.	1,951,000	1.19	1.10	1.51	1.21	1.51	1.30
Detroit, Mich.	1,595,000	1.37	1.47	1.23	1.61	1.59	1.45
Los Angeles, Calif.	1,354,000	.85	.65	.77	.85	1.04	.83
Cleveland, O.	940,000	.94	1.84	1.32	1.23	1.41	1.35
St. Louis, Mo.	900,000	1.70	1.68	1.13	1.35	1.25	1.42
Baltimore, Md.	851,000	1.68	.84	.94	1.11	1.20	1.15
Boston, Mass.	818,000	2.93	2.94	2.56	3.61	2.81	2.97
San Francisco, Calif.*	725,000	...	...	...	...	...	...
Pittsburgh, Pa.	700,000	.64	.96	.97	2.25	.70	1.10
Washington, D. C.	619,000	.80	.48	.90	.66	.66	.70
Milwaukee, Wis.	618,000	2.23	1.05	.95	.81	.83	1.17
Buffalo, N. Y.	599,000	1.69	2.25	1.04	1.49	1.34	1.56

*Does not report its losses.

Cities from 400,000 to 500,000 Population.

Minneapolis, Minn.	492,000	$2.35	$1.75	$1.88	$1.59	$2.59	$2.03
Cincinnati, O.	477,000	1.30	1.19	.56	1.34	2.50	1.38
New Orleans, La.	472,000	.92	.65	1.32	.71	.70	.86
Newark, N. J.	450,000	1.38	1.19	1.69	1.52	1.13	1.38
Kansas City, Mo.	445,000	1.72	1.96	1.91	2.38	1.63	1.92
Seattle, Wash.	402,000	1.16	1.58	1.11	1.77	1.47	1.42

Cities from 300,000 to 400,000 Population.

Indianapolis, Ind.	370,000	$1.02	$1.23	$1.15	$1.88	$1.38	$1.33
Louisville, Ky.	370,000	1.93	1.57	.60	1.45	2.52	1.61
Houston, Tex.	365,000	2.39	1.34	1.23	1.27	1.02	1.45
Rochester, N. Y.	335,000	1.63	1.16	.97	1.53	1.44	1.35
Denver, Colo.	325,000	1.00	1.11	1.33	1.03	1.36	1.17
Jersey City, N. J.	325,000	.42	.28	.38	.22	.32	.32
Portland, Ore.	320,000	2.14	1.98	1.56	1.35	1.15	1.64
Columbus, Ohio	310,000	.39	.71	.82	.92	2.23	1.01
Toledo, O.	309,000	1.10	1.17	.66	1.42	1.69	1.21
Dallas, Tex.	307,000	3.18	2.86	1.96	2.18	1.91	2.42
Oakland, Calif.	305,000	1.39	1.30	1.09	.92	1.40	1.22

Cities from 200,000 to 300,000 Population.

Atlanta, Ga.	297,000	$2.17	$ .67	$ .84	$ .83	$ .99	$1.10
St. Paul, Minn.	293,000	1.93	2.22	2.63	2.07	2.73	2.32
Memphis, Tenn.	283,000	2.35	2.23	.82	1.53	1.04	1.59
Birmingham, Ala.	277,000	1.28	7.95	2.20	.88	1.72	2.81
Akron, O.	255,000	.91	.65	.44	1.07	.51	.52
Providence, R. I.	253,000	.66	.77	.96	.58	1.01	.80
San Antonio, Tex.	253,000	.64	.41	.60	.60	.86	.62
Omaha, Neb.	225,000	3.77	1.20	1.33	1.23	1.39	1.78
Dayton, O.	220,000	2.33	1.02	.96	1.03	1.91	1.45
Syracuse, N. Y.	217,000	1.48	2.31	.51	1.58	1.17	1.41
Oklahoma City, Okla.	213,000	.38	.46	1.00	.63	.58	.61

Cities from 150,000 to 200,000 Population.

	Population	1933	1934	1935	1936	1937	Five-Year Average
Worcester, Mass.	199,000	$1.66	$2.35	$1.72	$1.61	$2.56	$1.98
Honolulu, Hawaii	195,000	.44	.27	.31	.32	.35	.33
Richmond, Va.	195,000	1.28	.46	.25	.47	.41	.57
San Diego, Calif.	180,000	.70	.97	.81	4.27	.32	1.41
Youngstown, O.	180,000	.47	1.23	.79	4.05	.69	1.45
Hartford, Conn.	177,000	.68	1.19	.91	.93	.99	.94
Fort Worth, Tex.	175,000	2.92	2.28	2.68	1.84	1.35	2.21
Long Beach, Calif.	170,000	.91	.38	.42	.48	.37	.51
Grand Rapids, Mich.	169,000	.88	.48	.77	1.41	1.71	1.05
New Haven, Conn.	163,000	1.75	2.72	1.33	3.28	1.16	2.05
Nashville, Tenn.	160,000	3.96	2.50	2.09	1.43	3.82	2.76
Flint, Mich.	156,000	.96	1.28	.69	1.17	1.23	1.07
Miami, Fla.	150,000	.75	1.14	.72	.49	1.03	.83
Springfield, Mass.	150,000	1.57	2.15	1.40	2.89	3.00	2.20

Cities from 125,000 to 150,000 Population.

Bridgeport, Conn.	147,000	$ .47	$ .88	$1.16	$1.11	$1.38	$1.00
Jacksonville, Fla.	146,000	2.73	2.00	1.18	1.26	1.66	1.77
Scranton, Pa.	145,000	1.76	2.84	.99	.92	1.69	1.64
Des Moines, Iowa	142,000	1.41	1.49	1.26	2.16	2.23	1.71
Tulsa, Okla	142,000	.84	.70	.94	.91	1.13	.90
Yonkers, N. Y.	142,000	1.72	.61	1.06	.96	1.08	1.09
Salt Lake City, Utah	140,000	1.73	.79	2.09	1.71	1.65	1.59
Paterson, N. J.	138,000	1.83	2.00	.50	3.70	4.12	2.43
Spokane, Wash.	135,000	2.21	.86	1.67	1.05	1.64	1.49
Norfolk, Va.	130,000	2.42	3.12	2.63	1.67	1.97	2.38
Albany, N. Y.	127,000	1.69	1.35	1.27	1.14	2.42	1.57
Kansas City, Kans.	125,000	.68	3.79	1.81	.79	.44	1.50

Cities from 100,000 to 125,000 Population.

Elizabeth, N. J.	124,000	$1.19	$ .56	$ .59	$ .73	$ .60	$ .73
Trenton, N. J.	123,000	2.04	.51	.40	.30	.80	.81
Chattanooga, Tenn.	120,000	2.63	1.23	.92	1.73	.96	1.49
Erie, Pa.	120,000	.68	.51	3.27	.41	.73	1.12
Fort Wayne, Ind.	120,000	.69	.74	.43	.98	1.15	.80
Peoria, Ill.	120,000	.89	1.27	31.93	3.16	1.45	7.74
Cambridge, Mass.	119,000	1.29	1.28	2.12	1.20	2.38	1.65
Camden, N. J.	119,000	1.68	1.49	1.28	1.41	.85	1.34
Fall River, Mass.	117,000	2.16	2.62	1.06	.69	1.74	1.65
Knoxville, Tenn.	117,000	.66	.98	.70	.49	.57	.68
Tampa, Fla.	117,000	.87	.71	2.92	1.21	1.77	1.50
Wichita, Kans.	114,000	.95	.65	.81	1.23	1.13	.95
Reading, Pa.	113,000	1.10	.35	1.21	.87	.83	.87
Tacoma, Wash.	112,000	1.85	4.70	5.06	2.05	.88	2.91
New Bedford, Mass.	110,000	.83	.61	.42	.89	.71	.69
Wilmington, Del.	110,000	2.37	1.12	1.32	3.24	.73	1.76
Evansville, Ind.	108,000	1.13	1.19	.78	2.61	1.54	1.45
Canton, O.	105,000	.57	.65	.52	.95	.61	.66

	Population	1933	1934	1935	1936	1937	Five-Year Average
Gary, Ind.	105,000	.61	.34	.57	.48	.29	.46
South Bend, Ind.	104,000	.75	.77	1.79	1.00	1.88	1.24
Waterbury, Conn.	104,000	1.98	1.51	1.04	3.29	2.72	2.11
El Paso, Tex.	103,000	.50	1.23	.31	.30	.26	.52
Somerville, Mass.	103,000	2.40	3.29	1.14	.88	2.05	1.95
Utica, N. Y.	103,000	1.84	1.69	1.02	1.10	.65	1.26
Lynn, Mass.	102,000	2.85	1.94	4.42	2.76	2.10	2.81
Duluth, Minn.	101,000	2.01	1.52	1.65	2.96	1.86	2.02
Lowell, Mass.	100,000	2.08	1.49	1.34	1.27	1.10	1.46

Cities in Which Loss Exceeded $5.00 Per Capita in 1937.

Ansonia, Conn.	$8.78	New Castle, Pa.	$5.90
*Muskegon, Mich.	8.37	*Springfield, Ill.	5.66
Alton, Ill.	8.05	*Chelsea, Mass.	5.46
Mason City, Iowa	7.85	Washington, Pa.	5.22
Danville, Ill.	6.70	Fresno, Calif.	5.18
Fond du Lac, Wis.	6.43	New Albany, Ind.	5.16
Texarkana, Texas	6.24		

*These cities have been in this class once before in the last five years.

Cities in Which Loss Was Less Than 25c Per Capita in 1937.

Brownsville, Texas	$ .04	East Cleveland, O.	$ .23
River Rouge, Mich.	.06	Hamilton, O.	.23
Cuyahoga Falls, O.	.08	Newport, Ky.	.23
Harrisburg, Pa.	.08	Richmond, Ind.	.23
Athens, Ga.	.16	Winston-Salem, N. C.	.23
Raleigh, N. C.	.16	Hammond, Ind.	.24
Maywood, Ill.	.17	Rocky Mount, N. C.	.24
Covington, Ky.	.21	Santa Ana, Calif.	.24

U. S. Losses Slightly Higher for First Part of 1938.

Fire losses in the United States for the first five months of 1938 were $131,733,620, which is $588,141, or about one-half of one per cent, more than for the same period last year, according to estimates of the National Board of Fire Underwriters.

	1935	1936	1937	1938
January	$23,430,504	$27,729,930	$25,069,895	$27,676,337
February	25,081,625	30,909,896	28,654,962	26,472,626
March	24,942,703	29,177,406	29,319,029	29,050,968
April	23,267,929	25,786,835	26,663,854	25,616,112
May	21,238,205	21,479,380	21,437,739	22,917,577
Total—5 months	$117,960,966	$135,083,447	$131,145,479	$131,733,620

Canadian Fire Losses, 1937.

Canadian fire losses for the year 1937 amounted to $22,746,058, according to statistics furnished by J. Grove Smith, Dominion Fire Commissioner. This is an increase of $1,196,574 (or 5.5%) over the 1936 property loss, but is about 30% under the average annual loss for the past ten years. The number of fires reported in 1937 was 44,660, which is an increase of 4.7% over the 42,644 reported in 1936. Loss of life from fire decreased from 347 in 1936 to 246 in 1937. The average loss of life from fire in Canada during the past ten years is 280.

A Decade of Fire Losses in Canada.

Year	Property Loss	Per Capita	Year	Property Loss	Per Capita
1928	$36,402,018	$3.79	1933	$32,676,314	$3.15
1929	47,499,746	4.85	1934	25,437,840	2.44
1930	46,109,875	4.70	1935	23,221,521	2.12
1931	47,117,334	4.54	1936	21,549,484	1.95
1932	42,193,815	4.06	1937	22,746,058	2.04

Population Group Loss Classification.

Group	Total Loss, 1937	Per Capita
Cities over 10,000 population	$6,913,482	$1.52
Towns 5,000 to 10,000 population	946,025	2.31
Towns 1,000 to 5,000 population	1,816,501	2.89
Villages under 1,000 population	2,904,264	7.06
Rural districts	10,165,786	1.71
Total	$23,746,058	$2.04

Occupancy Record.

	1937		Ten Years 1928-1937	
	No. of Fires	Loss	No. of Fires	Loss
Dwellings (all classes)	34,227	$7,951,273	298,888	$106,550,163
Farm property (excluding dwellings)	3,952	2,869,154	41,286	38,016,429
Retail and wholesale stores	3,460	5,147,200	44,779	84,297,033
Manufacturing properties	824	3,604,941	8,804	59,046,381
Churches, schools, and institutions	433	1,301,916	5,291	18,814,226
Miscellaneous property	1,764	1,871,574	39,186	17,229,773
Total	44,660	$22,746,058	438,234	$323,954,005

Per Capita Fire Losses of Canadian Cities Over 100,000 Population.

City	Population	Per Capita Loss, 1937	City	Population	Per Capita Loss, 1937
Montreal, Que.	819,000	$2.09	Hamilton, Ont.	156,000	$3.83
Toronto, Ont.	631,000	1.24	Quebec, Que.	131,000	2.68
Vancouver, B. C.	247,000	2.12	Ottawa, Ont.	127,000	1.74
Winnipeg, Man.	219,000	1.13			

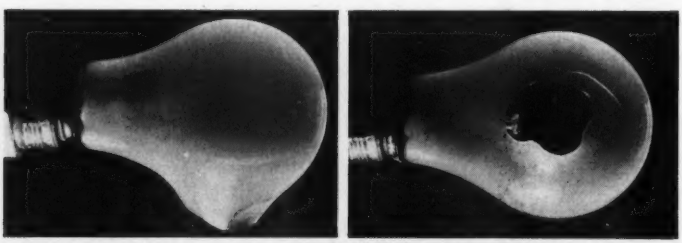
An Interesting Electric Light Bulb Fire.

By Lawrence Daw,
Underwriters' Association of New York State.

There are several interesting features of a recent fire in Syracuse, N. Y., where an electric light bulb in a clothes closet of a two-family dwelling caused a small fire. The closet was on the first floor, under the stairway, where there was very little head room. The light fixture was on a wooden strip on the side wall about four feet above the floor and was of the porcelain receptacle type with pull chain. The wooden strip was also provided with clothes hooks.

Hearing her baby cry in the room off which the closet opened, the mother rushed in and saw smoke coming from the closet. She called her husband, who opened the door, tore out the burning clothes and extinguished the fire with nominal damage. The mother said that the light had probably been burning for half or three-quarters of an hour before the fire was discovered. A heavy plush wrap which showed the most damage apparently had been hung over both the bulb and the hook adjoining it, thereby causing sufficient incased heat to melt the sealing compound at the base, permitting it to flow into the lower portion of the bulb, which was in a horizontal position. The compound then vaporized and ignited, generating sufficient temperature to melt the glass, as shown in the accompanying photographs. The only other damage was the burned filament. The bulb was not shorted in the base. The charred wood showed the fire had occurred immediately at the light.

Another possible cause might have been a defective base, but this seems unlikely, although the bulb (40-watt, 115-volt) might have been a refill. The equipment had not been inspected by the Underwriters and the location of the receptacle was a violation of the National Electrical Code. The requirements of the Code in this regard are therefore well justified from this experience. Had this fire occurred at any other hour than 1:30 P.M., when the family was present, the results might have been serious, not only for them, but also for the family living upstairs.



Side and bottom views of the light bulb which caused the fire.

Portable Water Spray Nozzles.

By Arthur L. Brown, Chief Engineer,
Factory Mutual Laboratories (Member N.F.P.A.).

Not so many years ago, any use of water on fires in oil or flammable liquids would have been considered poor fire-fighting. Today increasing attention is being given to the very promising development of water spray nozzles for such fires under certain conditions. The story of this changing viewpoint shows that constant progress and improvement are being made in fire protection as in other fields.

Processes involving oils and hazardous liquids in open containers, such as dip tanks, impregnating tanks, quenching tanks, and similar equipment, introduced a serious fire hazard in industry. Generally, this type of hazard has been safeguarded by specialized extinguishing methods such as automatic foam, carbon dioxide gas flooding systems, and carbon tetrachloride spray, all of which have proved satisfactory and effective for their intended use.

Care must be taken that the quantity of the special extinguishing materials is adequate, so that it will not be used up before a fire is extinguished. In contrast, water supplies as generally laid out for fire protection have practically unlimited capacity.

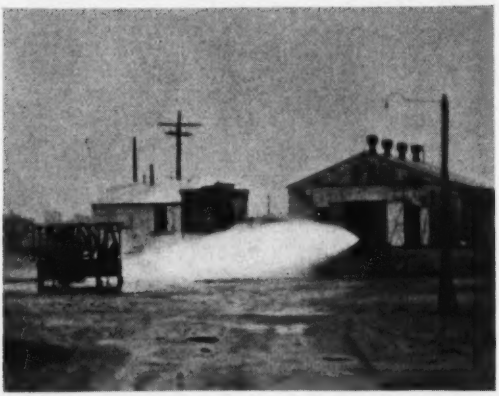
Overflow Hazards.

The difficulty in using water from hose streams and sprinklers on fires in flammable liquids or oils has been that the water floats the burning liquid, causing tanks to overflow, and spreading the fire. Under most conditions, such overflowing occurs before the hose stream or sprinkler discharge can produce sufficient effect to extinguish the fire.

Recently, spray nozzles supplied by hose lines for portable use have made their appearance. The Factory Mutual Laboratories have made extensive tests on this type of protection under actual fire conditions. A series of these tests were photographed in color with amateur motion picture equipment, innovating a new technique in recording and reporting results. The film was displayed before the Annual Meeting of the N.F.P.A. in Atlantic City last May. The opportunity to witness the action of the equipment being investigated, previously limited to a small laboratory staff, was given to the entire convention, and will be available in the future to other interested organizations.

No knowledge and no experience is more valuable to the individual, or is more positively and permanently remembered, than that accumulated by seeing. For this purpose the colored motion picture appears to be a very

This article is based on a talk by the author, illustrated with colored motion pictures, presented at the 1938 N.F.P.A. Annual Meeting in Atlantic City.



On this page are pictures showing the relative range of the spray from three types of spray nozzles. All are supplied with water at a pressure of 100 lbs. per sq. in. In the upper picture a nozzle which produces spray by disturbed, high-velocity flow is discharging about 165 gallons per minute, attached directly to a 2½-inch fire hose line. This is the greatest capacity of any nozzle used in these tests.

The center view shows the range of a nozzle which produces spray by mixing a solid central stream with an outer spiral discharge. This nozzle also attaches to a standard fire hose and discharges about 155 gallons per minute.

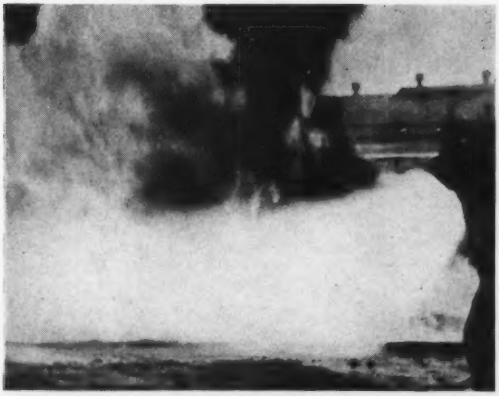
The lower view shows the peculiar hemisphere of dense, fine mist which is the discharge of a nozzle producing spray by impinging jets. The discharge is only about 50 gallons of water per minute; the nozzle is attached to a 1½-inch hose.

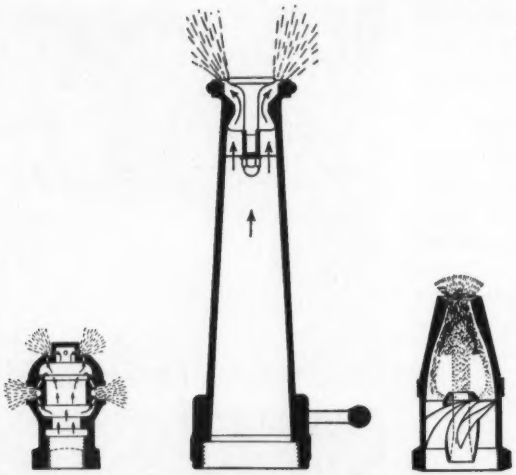
The pictures on this page show the actual handling on a fire of the three types of nozzle shown opposite. The high capacity nozzle (top) requires considerable exertion by the fire fighters in directing the stream at the desired spot. It is similar in this respect to an ordinary play pipe.

In the 155 g.p.m. nozzle (center) two sets of handles are provided on the play pipe, which simplifies the task of the fire fighters. There is a 45° angle between the line of discharge and the barrel of the play pipe.

The low velocity nozzle (bottom) is handled by a long curved applicator that makes it possible for the water to be discharged directly over the fire. The low capacity makes this nozzle relatively easier to handle than the nozzles having greater discharge.

All of these pictures show the initial attack on fires, where the fire fighters are driving the fire to the back of the tank.





Three types of spray nozzles approved by the Factory Mutual Laboratories. In the nozzle at left, impinging jets produce a low-velocity discharge of fine mist; center, passages of varying diameter result in a disturbed flow which at high velocity produces a dense spray; right, a central solid jet meets a twisting, converging current to produce a solid cone of spray.

valuable substitute for the original event. It can be seen and studied whenever and wherever desired, and by one or many persons. Slow motion and repeated showings provide opportunity for more complete observation than does the single original action. Color not only adds attractiveness and interest, but, of much greater importance, shows ordinary fire and flame in the natural color and avoids confusion with white vapor or smoke or other objects producing almost equal effects on the ordinary film.

The motion pictures were prefaced with a warning that the tests shown were of limited scope, that the investigation of which they were a part was not complete, and that, although successful extinguishment was accomplished in each case, final conclusions had not been reached. All important factors could not be covered in the limited laboratory tests shown. It was shown, however, that, notwithstanding prevalent past opinion, water can be used effectively for extinguishing fires in the less volatile and less hazardous classes of combustible or flammable liquids.

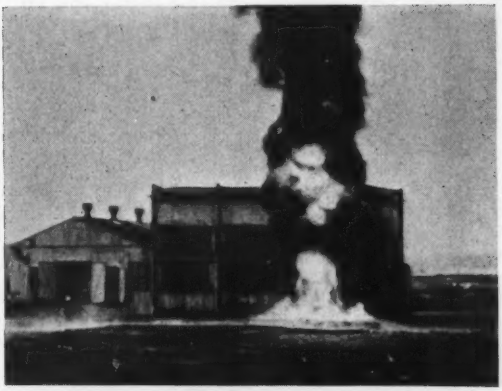
Number 4 fuel oil, commonly used in industrial burners and having an open-cup flash point of about 240° F., and also kerosene with an open-cup flash point of about 160° F. were used as the fuels in the series of test fires. They represent a class of flammable liquids for which water, as previously applied from extinguishers or hose streams, had not been an effective extinguisher. More volatile and more flammable materials having flash points below normal atmos-

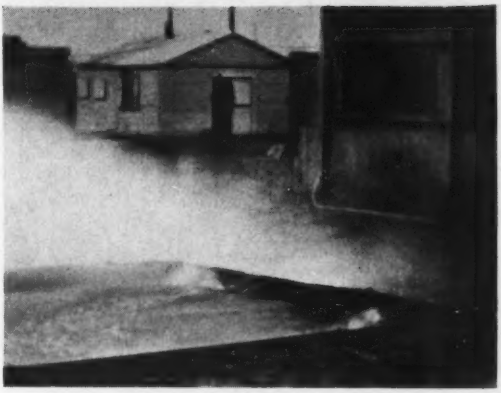
These three pictures show the actual attack of a kerosene fire burning in a large ground-level tank. Because the fires are out of doors, the accessibility and visibility for the fire fighters are about as favorable as it is possible to have them.

The nozzle used is an experimental model investigated by the Factory Mutual Laboratories and has a capacity of about 150 g.p.m. at 100 lbs. per sq. in. pressure.

The first attack (center) is to drive the flames away from the nearest edges of the tank, and then to spray the entire surface as quickly as possible, so that the cooling effect of the water will reduce the volume of the fire, make the heat less intense, and allow the fire fighters to approach closer and work with less discomfort.

Near the final extinguishment (bottom) the flames continue persistently at the back edge of the tank. The fire has been driven back to this point and the tank sides cooled to reduce the possibility of re-ignition.





A spray nozzle of relatively high capacity being used on a ground level tank of No. 4 fuel oil. Notice the apparent difficulty with which the fire fighters are holding the stream at the desired point.

pheric temperatures had not been included in the test program, and no effort was made to determine practical limits in this direction.

The sizes of the fires used were selected as reasonably representative of typical industrial hazards and were believed sufficient to avoid extreme scale-effects which must always be considered. The spray nozzles were of commercial sizes. They can be used manually without difficulty by moderately experienced fire fighters, and require somewhat less water than the usual fire hose stream. To produce an effective spray the pressure at the nozzle should not be less than about 50 lbs. and preferably it should be greater.

The pictures accompanying this article have been taken directly from the colored motion picture film shown to the annual meeting. The scenes required careful selection in order to retain in black and white the distinction between spray, smoke and flame. They are intended to give an idea of the extent and conduct of the tests.

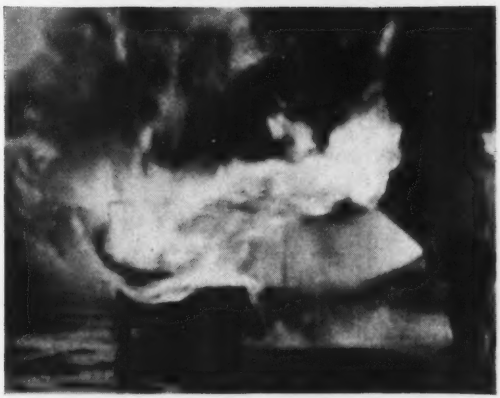
Water spray may affect the burning of flammable liquids by cooling below the flash point, by blanketing with a continuously replenished film of water, by the formation of steam which helps to exclude air, or by forming a non-burnable emulsion over the surface. The spray undoubtedly has a greater cooling effect than the same amount of water applied as a solid stream or discharged from sprinklers. Very likely the extinguishing action of spray nozzles is due to a combination of these factors, which probably also vary according to the type of spray discharge and the characteristics of the burning liquid.

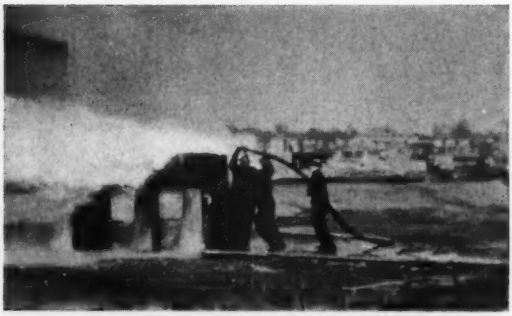
Portable spray nozzles permit using water as a secondary line of defense in instances where other types of fire-extinguishing equipment have failed to control fires in oils or flammable liquids. Used in this way they have proved effective in actual fires. In one instance, during a fire in a varnish-mixing tank at a paint plant, ten sprinklers opened, and firemen first used a large hose stream; but when they found that this was spreading the fire, they brought in a spray nozzle which quickly extinguished the fire.

Fire fighting in this 48 square foot tank of kerosene was obstructed by automobile fenders hung over it to approximate as closely as possible conditions found in dip tanks with freshly painted work hanging above them. The hazard of the kerosene, however, is somewhat greater than that of typical dipping japan.

The center view shows the fire fighters first approaching the spectacularly flaming tank with the spray nozzle. They have already succeeded in driving the largest part of the flames to the back of the tank.

Approaching closer (bottom) they are able to extinguish the remaining fire without difficulty. The obstructions hanging over the tank did not in this case interfere appreciably with the fire extinguishment.





To test the spray nozzles under difficult fire fighting conditions, this 48 square foot tank of kerosene was elevated so that the top was 5½ feet above ground level. The fire was successfully extinguished.

Similarly, during a fire in a quenching-oil tank in an agricultural implement factory, employees tried to put out the fire with a 40-gallon foam extinguisher. Such extinguishers are normally suited for fires of this kind, but in this case the length of the tank and cross baffle-plates prevented laying an effective foam blanket before the supply of foam was exhausted. Firemen responding to the alarm brought in a spray nozzle and quickly put out the fire.

In still another instance, arcing in an oil-filled terminal box produced a serious explosion and fire in the switch room of a large public utility plant. As the burning oil spread over the floor, employees used all available carbon dioxide and carbon tetrachloride extinguishers, but because of the intensity of the fire the extinguishers were all emptied without success. Hose streams were also used, but the pressure was low, and the fire continued to burn. When public firemen arrived, they carried in spray nozzles fed through hose lines at ample pressure from pumpers and, as in the previous instances, the fire was quickly extinguished.

This review of the development of portable spray nozzles records progress to date. Much study is still necessary to show fully the basic principles of the action of water sprays and to develop standards and specifications for their use. Although such work is a gradual process which requires time, present indications are that water sprays will become a recognized form of fire protection, fulfilling a definite need in the control of special types of fires.

Testing and Inspection for Fire Prevention.

By James J. Duggan (Member N.F.P.A.),
Carbide and Carbon Chemicals Corp., So. Charleston, W. Virginia.

Fire and accident prevention and the safety to life of employees have always been major problems of industry. They have been partly solved through experience and the work of technical bodies in the preparation of standards of safety. In large industrial plants workers are trained to be safety conscious, are instructed in good housekeeping and the elimination of fire hazards. Plants are sprinklered and otherwise equipped with recognized and efficient fire protection. But one of the major causes of industrial fires and accidents, the mechanical failure, has continued to take its annual toll. From a fire standpoint such mechanical failure is especially important where it results in the release from pressure vessels of flammable liquids, vapors or gases, or other material which may cause fire or explosion.

Important in reducing fires and explosions from this cause has been the work of national testing laboratories. It is now possible to be sure that new pressure equipment is adequate for its intended purpose. But it is important

Standard test gauges are calibrated and set accurately by employing this apparatus. Standard weights set on a piston create standard pressures in the apparatus which are transmitted to the gauge being calibrated. If the gauge does not read properly, either its hand is reset or the linkage inside is adjusted to give true readings over the entire range. Whenever necessary, new parts are used to replace worn out, corroded or defective parts of the gauge mechanism.

Special equipment is often necessary to carry on test and inspection work efficiently. This indicator is used to equalize the strain on elevator cables and guy lines, and to determine the safe working loads on hoists, cable slings and other cable equipment.

that such machines be given proper maintenance, that they be kept adequate for their purpose and not allowed to become hazardous as the action of corrosion, erosion or metal fatigue proceeds. Ultimate failure must be forestalled as surely as is initial failure.

In December of 1934 the Carbide and Carbon Chemicals Corporation plant at South Charleston, West Virginia, organized a special department to prevent mechanical failure and consequent fires or explosions due to the release of flammable liquids or gases by regular test and inspection of all plant equipment. To guarantee independent judgment the new department was placed outside the jurisdiction of those in charge of production and equipment maintenance. The service of the department is advisory, and the supervisor of each plant operation retains the responsibility for the safe operation and maintenance of his equipment.

The results obtained from this advisory service, however, are substantially equivalent to those of a mandatory program, for no plant supervisor wishes to assume the responsibility for continuing equipment in operation after it has been shown to be unsafe by competent engineering tests.

During the past three and one-half years the program of periodic test and inspection has made effective progress. Definite procedures have been established and all equipment, machinery, instruments, and safety devices within all the plants of the Carbide and Carbon Chemicals Corporation are now on

Vent valves, flame arresters, vacuum relief valves and all auxiliary equipment on atmospheric storage tanks are completely inspected and if necessary reconditioned each month. The inspector is here shown checking a flame arrester.

schedule for regular retest and inspection. A method of identification of each piece of equipment is used, the various types being classified in separate groups and numbered. The maximum life of equipment in any service has been arbitrarily placed at ten years and retest and inspection dates fixed at one-half this period. Where corrosion or other deterioration is found, this estimated maximum life is reduced proportionately and the time prior to retest is lessened. Tanks and equipment for the storage of liquids, gases and vapors at atmospheric pressure are carefully inspected monthly. Safety valves and pressure gauges are tested and inspected at least once each year.

Operating departments often request a test to prove the safety of equipment during the time afforded by a regular unit shut down, even though the allowable time between tests has not been exceeded. Such requests prove that the worth of the service is recognized. A detailed report is made of each test, inspection, or repair by the mechanic doing the repair work or the inspector supervising the test or inspection. The exact condition of the equipment, in-

Strict adherence to standard procedures quickly reveals defective equipment. The above illustration shows a leaking seam in a storage tank. Repair must be made at the earliest possible moment. If necessary, inspectors check conditions such as this daily until satisfactory correction has been made. Repairs made as soon as the defect is discovered often prolong the life of equipment ten-fold and eliminate costly and extensive replacements.

For insulated tanks only small portions of the insulation need be removed to inspect the knuckle or rivet heads and seams. In this case the knuckle was painted at several places with whitewash before the test pressure was applied. If excessive yielding or strain had occurred in the metal during the test it would be evidenced by a flaking of the whitewash coating. If any yielding does occur the test pressure is reduced immediately and a more detailed examination made. This procedure is followed only where deterioration is evident or when the operating pressure is to be increased. Otherwise a standard test is applied.

cluding actual working pressure and temperature, amount and nature of deterioration, type and nature of service to which the equipment is subjected, the type and extent of the repair, etc., is given. Original specifications and test requirements, design and allowable working pressures, installation date, service record, maintenance cost and all other pertinent information previously compiled on the equipment are added to the report. By comparing each report with the previous one it is a simple matter to determine definitely the rate of deterioration and estimate the maximum safe operating life. Reports are circulated to all interested parties and then filed for future reference.

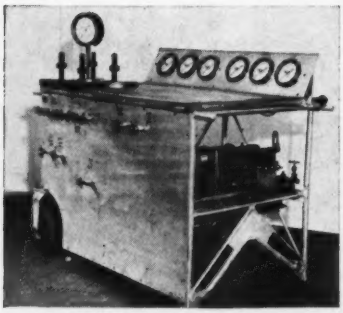
Inspection Manual.

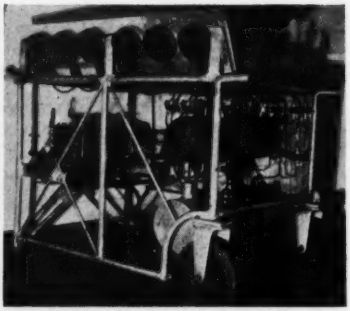
In order to systematize the work and avoid the possibilities of misunderstandings regarding proper procedures in testing and inspecting, a manual was issued which prescribes definite procedures on the following subjects:

1. Shutting down and blanking off equipment.
2. Purging and ventilation of equipment.
3. Cleaning equipment.
4. Operating characteristics of all plant products.

This 35 ft. diameter, 20 ft. high, 160,000-gal. aluminum tank represents an accomplishment in the welding and metal fabrication arts. Inspection procedures may require expansion to cover such equipment.

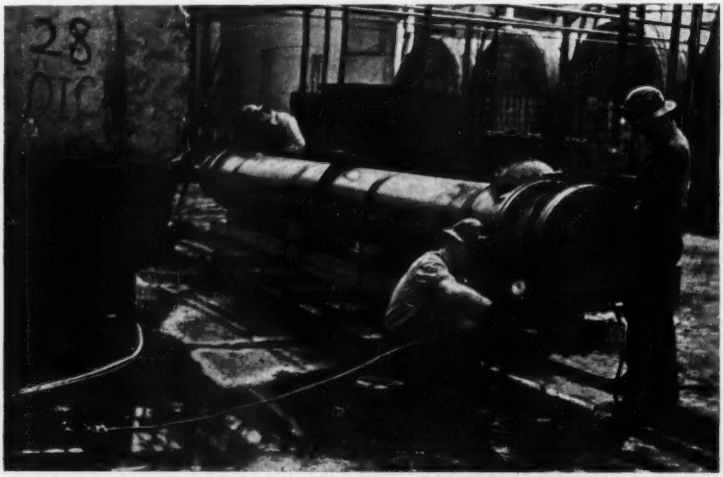
5. Procedures for inspections.
6. Repairing of equipment.
7. Testing of equipment.
8. Return to service.
9. Rearrangement or change of service.
10. Dismantling and junking of condemned equipment.
11. Methods of determining allowable operating pressures.
12. Inspection periods and corrosion rates.
13. Corrosion rates of metals in plant products.
14. Record system and use of standard forms.
15. Tools and equipment for test and inspection work.
16. Tables, formulas, and useful information.
17. Plant safety rules and regulations.
18. Routine safety committee inspections.
19. Painting standards.
20. Fire protection regulations.





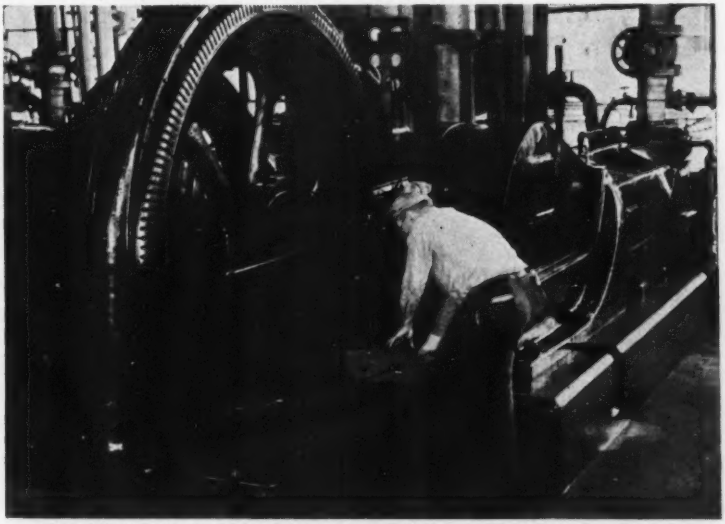
This apparatus needs only to be wheeled to the desired location and an air connection made to be ready for testing safety valves or pressure gauges up to 1000 pounds per square inch. The picture on the left shows the control side of the machine with a pressure gauge connected to the test block. On the right is a rear view, showing the details of construction. Air pressure is obtained by pumping water into an air chamber. Valves on the machine front control the air pressure, pump, water circulation, and the test gauges. On the back of the machine, the pump unit is located at the left, and the water pressure tank and water storage tank on the upper and lower right. Aluminum framework and supports and copper tubing and fittings have been used wherever possible to reduce weight.

This portable apparatus has proven so efficient that the cost of testing safety valves and pressure gauges is of little importance.



Standard procedures in this plant require that all equipment be subjected to a test equal to the original acceptance requirement after each repair or change of service, or after an interval not exceeding five years of continuous service. If the original test data are not available, the test requirements are based on accepted code requirements governing new equipment. Any leaks or defects found during such tests are sufficient basis to reject the equipment for service until repaired properly and a successful test has been established. This photograph shows a typical field test on a heat exchanger that has just been overhauled.

A typical set-up for making a hydrostatic test. In this scene a piece of piping from the compressor is being subjected to a test pressure of twice the working pressure. Sections of the piping and all auxiliary equipment in this particular compressor room will receive a similar test. This procedure is normal when a complete operating unit is shut down and all machinery and equipment is overhauled. Of particular interest is the fact that the equipment shown in this photograph has been in continuous service since 1924. All piping and auxiliaries were found to be in equally good condition after this long period of service. Piping or equipment that sucecssfully stands the reapplication of the original test pressures can be considered as safe and efficient as new equipment.

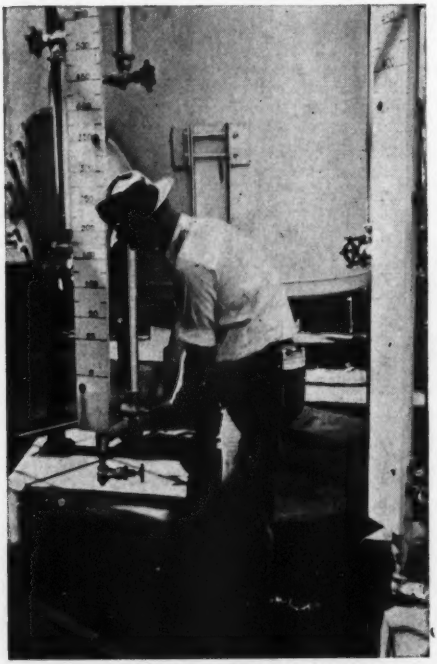


Periodically all electric motors are tested thoroughly. Here an electrican is testing the insulation of a motor with a megger. Such tests as these, and also inspections of brushes, collector rings, and other parts, are important in order to prevent the occurrence of ignition points. Many forced shut downs are prevented by this procedure.

The material in the manual was assembled from the most authoritative sources and the procedures are followed by all plant personnel.

As an example of the work accomplished in three and one-half years of operations at the South Charleston plant alone, the following figures are given:

Manufacturing equipment and machinery tested	1,723
Safety valves tested	6,756
Pressure gauges tested	11,313
Equipment inspected monthly	940
Manufacturing equipment condemned for service	46
Safety valves condemned for service	15
Pressure gauges condemned for service	396
Mechanical failures of equipment in normal service	None



Each month, when routine inspections are made, particular attention is given to the condition of measuring devices, such as gauge glass columns and float gauges. The inspector is here shown operating a cut-off valve on a gauge glass header to determine if it is in satisfactory condition for operation in event of emergency.

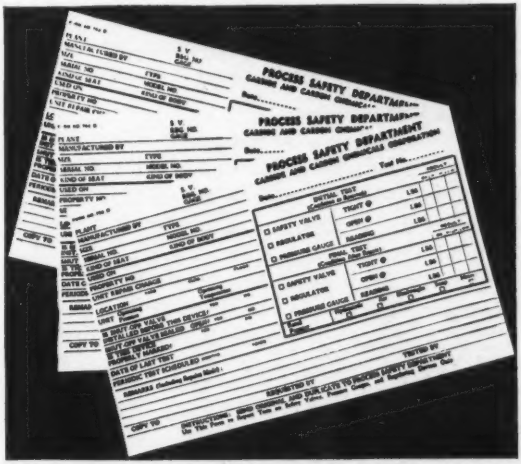
Analysis of Results.

Analysis of the above figures indicates that over two and one-half per cent of the major equipment tested had to be condemned for service. When so condemned the equipment is removed to a less severe service or completely removed from service.

The causes of fires and explosions in materials that escape from processing equipment are usually listed by ignition sources. Though ignition sources actually originate a fire or explosion and all possible precautions should be taken to eliminate them, no ignition would be possible without the presence of some combustible material. Experience of the Carbide and Carbon Chemicals Corporation proves that many potential fires and explosions are removed through the elimination of unsafe operating equipment. A systematic and thorough test and inspec-

tion program for equipment and machinery will keep a plant new and should be recognized as a major step in fire prevention.

The system employed by the Carbide and Carbon Chemical Corporation has proven workable and inexpensive.



The practice of making a record of routine tests is rigidly enforced. The information revealed through this medium has been responsible for the elimination of many defective instruments and equipment and has increased the operating efficiency of the entire plant.

Making Fire Prevention News.

By Strafford Wentworth,
N.F.P.A. Engineer.

The local newspaper can be one of the most compelling forces in fire prevention education. Dealing on a local scale, it is in a much more advantageous position to produce results than is any possible national force. Its pages are read as a friendly reminder from one citizen to another rather than as uncalled for advice from abroad.

For several decades, the local newspapers of America have been distinguishing themselves by their coöperation during Fire Prevention Week. Even small towns report hundreds of column inches devoted to what the firemen say. Editorial pages in many cases bear appropriate fire prevention messages and deal forcefully with the local conditions. The following editorial from the Atlantic City *Daily World* is a good example of the courageous stand which has been taken by some editors:

"We Have Done Our Part.

"As Fire Prevention Week activities continue, several salient features occupy conscientious thought on the subject.

WE HAVE NO FIRE PREVENTION CODE.

WE HAVE THE SECOND HIGHEST PER CAPITA FIRE LOSS IN THE STATE.

AUTHORITY FOR INSPECTING RUBBISH AS A FIRE HAZARD IS VESTED IN THE BOARD OF HEALTH. A PARADOXICAL SITUATION WHICH EXISTS IN NO OTHER CITY IN THE UNITED STATES.

Yet the cost of adopting a comprehensive code, which—experiences in other cities have shown—considerably cuts the fire toll everywhere, can be summed up in a few words—THERE IS NO COST INVOLVED.

The passage of proper ordinances transferring the fire prevention authority of the Board of Health and Building Department to the Fire Department is all that is needed to double the safety of the public against loss of life and property.

The city is recognized by the National Board of Fire Underwriters, National Fire Protection Association, and the Schedule Rating Office of New Jersey as notoriously lacking in fire prevention facilities.

On innumerable occasions during the last decade these organizations have repeatedly advised and urged the city to adopt a fire prevention code. Outstanding civic leaders have reiterated the advice in an attempt to have the city rulers correct this HAZARDOUS and RIDICULOUS condition.

And yet the situation remains where Atlantic City can boast of a commendable and hard-working fire department, but at the same time realize it is overlooking an administrative duty which embraces the welfare of every man, woman, and child, who look forward to the red-helmeted fire fighters as unexcelled heroes.

No blame for the lack of a fire prevention code in Atlantic City is intended to be cast on any city official or civic group, but it has been the purpose of the ATLANTIC CITY DAILY WORLD to make public a contradiction in the city's government which in all probability has been an inadvertent oversight.

In a series of articles, the facts and statistics regarding the existing harmful consequences resulting from a lack of proper fire prevention facilities have been shown.

Moreover, a simple expedient method has been suggested whereby the city's fire loss will be cut in half. This same suggestion, it must be remembered, has been repeatedly advanced by the aforementioned national associations.

> The Chamber of Commerce now has under consideration the matter of formally recommending to the city commission that a fire prevention code be adopted without further delay.
>
> This paper has done its part; the rest is up to the C. of C., the city commission and other civic-minded individuals and organizations."

There can be no doubt that such hard-hitting editorial treatment of the local fire menace had a profound effect on the citizens of Atlantic City.

Vivid and impressive cartoons have often been used to carry fire prevention messages during Fire Prevention Week to those who do not read editorials and the local news. The ability of a good drawing to create a lasting impression from a casual glance makes it an important part of fire prevention publicity. Most cartoons used in the past have depicted the annual fire waste; some, the individual fire hazards. Fire hazard cartoons have proven to be an interesting introduction to fire hazard stories for those who want to pursue the subject further. A wealth of such stories might be written. The subject of gasoline and kerosene in the home needs never be treated without dramatic illustration, the cigarette as a fire cause never without impressive statistics, the hazard of rubbish never without its interesting phase of spontaneous ignition. Each hazard can lend itself to some story or fact that will hold reader attention. During Fire Prevention Week, stories of the fire department inspections that are carried on in the homes of many cities never fail to make good news copy.

These are some of the ways in which newspapers have coöperated in putting their influence behind fire prevention during Fire Prevention Week. Results have been good, good enough to leave little doubt of the value of the news press to public fire safety during the one week when they elect to push fire prevention. It seems probable that year-round publicity would accomplish much more.

There is a fire prevention activity to which the newspapers are committed for all time. The manner in which the press has handled its commitment, however, has caused the fire prevention fraternity some anxiety in past years. All year long the local press must print stories of the local fires of importance and others outside, which are serious enough to be regarded as national tragedies. It was not so many years ago that newspapers commonly ignored the important facts of the fires which occurred, facts which would play a large part in the prevention of their recurrence. They dramatized the screams, the scanty clothing of escaped occupants, the redness of the flames, the heroism of the firemen and made other sparkling overstatements, but almost always failed to put across the important educational message that was there. Public reaction has done much to conquer such treatment. As complaints flowed over the editor's desk, faster press methods were already making accurate fire stories possible in time to distinguish them from history. Fire chiefs and firemen who customarily are first to know the

facts about fires soon began to coöperate with the newspapers when they found that their statements were treated with intelligence. Stories began to talk expertly of blocked stairways, hollow walls, wooden shingles, and other fire hazards. Scare headlines are now often followed by columns having an important educational function. There is nothing like a well-reported fire in the news to make the importance of the responsible hazard felt.

Most ambitious undertaking in this way was that of Carl S. Steup, Director of the Fort Wayne Fire Prevention Bureau. Several years ago with the coöperation of the *Fort Wayne News-Sentinel* he gave to the people of the city every week a description of the local fires and the factors responsible for them. The following is a typical story:

Fort Wayne Fire Loss Small Last Week.

BY CARL S. STEUP

Director of the Fire Prevention Bureau of the Fort Wayne Fire Department.

The fire loss in Fort Wayne for the past week amounted to only $895.00, in spite of the fact that the firemen were called out 21 times, two of these calls being for fires outside of the city. As usual, however, much of the loss can be attributed to preventable fires.

Since several of the fires of the past week were caused by oil burning devices of one kind or another, the theme of this message will be the hazards of oil burners and fuel oils.

Probably the type of oil burning device most commonly in use is the popular kerosene cook stove. There are some practices more or less generally followed by the users of these devices which should be discontinued or avoided to insure against fire.

These are: first, the practice of filling the reservoir while burners are lighted, and, second, the practice of placing papers on the shelf under the burners or on the wall back of the stove, to catch bothersome grease. These two practices have caused more than one fire.

Dangers of Heater.

Almost equally as popular is the portable kerosene heater. It is quite important to know that the safe use of kerosene burning devices for heating purposes depends largely upon establishing and maintaining complete combustion. When combustion becomes incomplete, carbon deposits form, which cause trouble that usually terminates with a fire.

To burn kerosene successfully and safely for fuel, a generous supply of oxygen is necessary to support properly complete combustion. So it is unwise to use a kerosene heater in a small room or confined area, from which the supply of oxygen might readily become exhausted.

There is a case on record where a family, attempting to heat water with which to wash clothes the next day, left burners of a kerosene cook stove burning under the wash boiler, in an average sized kitchen when they retired. Shortly after midnight a fire started from this cause.

Fuel Oil Burners.

The amateur or home made type of fuel oil burner, usually consisting of a gasoline tank of an old automobile, placed above the stove or furnace, to provide gravity by means of which the oil might flow through a pipe line that is equipped with no other control than an ordinary globe valve, is very dangerous and should never be used.

It is quite important in burning fuel oil, that complete combustion be maintained as, like kerosene, incomplete combustion rapidly carbonizes the burner.

The practice of using oil drained from the crank cases of automobiles, should be avoided also, as this is quite dangerous. Oil secured from this source, unless re-refined, always contains some gasoline.

Should enough gasoline be present and conditions right, an explosion could occur with disastrous results.

One of the fires of the past week was caused by an improvised oil burner. Fortunately it was not a bad fire.

Such a column, though undoubtedly of important educational value, may be subject to the natural disadvantages of thoroughness in anything modern. Good citizens of today have too much to read of foreign wars and local dictator hysteria to take the time for much more than a headline on the local fire loss. Newspapers in general are not yet convinced of the news value of the many small fire losses that, when added together, subject the American citizen to such a staggering economic burden. The full significance of the fact that the per capita loss in America is ten times that of any European nation seems never to have been felt.

Shorter Press Items.

Two examples of the brief treatment sometimes used to overcome the difficulties of a long educational column, are found in Cincinnati, Ohio, and Omaha, Nebraska. They differ only in the type arrangement. The following are typical examples of each:

Fires for One Day in Cincinnati.

Time	Location	Cause
1:24 A.M.	1416 Central Avenue	Automobile, Gasoline
9:17 A.M.	283 McCormick place	Overheated Furnace
6:50 P.M.	1309 Vine Street	Leaking Gas Pipe
9:59 P.M.	Gilbert Avenue and Eden Park	Grass Fire
10:35 P.M.	1540 Central Avenue	Careless Smoker

Prevention Reminder:—Matches should never be carried loose in one's pocket. A match may easily be dropped into flammable materials, and, if stepped on, cause a fire.

BUREAU OF FIRE PREVENTION CINCINNATI FIRE DEPARTMENT

Omaha Fire Calls.

(Daily reminder: a "blown" fuse is warning of trouble in the wiring system of your home...It calls for your investigation.—Omaha Fire Department, Bureau of Fire Prevention.)

Monday

9:04 A.M., 5644 Lake Street, weeds.
10:40 A.M., 5121 Burt Street, Residence of L. E. Kurtz, overflow of oil furnace.
10:58 P.M., 213-15 North Tenth Street, Red Ball Transfer Co., Ignition of gas fumes.

In many cities and towns of the United States and Canada, regular Fire Prevention Week in October is supplemented by a Spring Clean-up Campaign, held during the period most opportune for the community. In Pocatello, Idaho, the local press co-operated with the campaign by printing editorials, news stories and cartoons like this in its support.

PREVENT FIRE
REMOVE THE HAZARDS
It's too Late when they say It started-
PLAY SAFE!
Clean Up and Paint Up
MAKE PROPERTY SAFE- SAVE LIVES

The latest innovation in fire prevention publicity reported to the N.F.P.A. is being used in Akron, Ohio. Park L. Roberts, the director of the Akron Fire Prevention Education Bureau, worked out a series of fire prevention problems in cartoon form which were offered to the city in the columns of the *Akron Sunday Times*. Each cartoon depicts a room of an average house in which there are common fire hazards. One week these hazards are illustrated without enumeration; the following week they are numbered and discussed in the column. On the opposite page are a story and cartoon on kitchen fires. On the week following there was a discussion of overloaded electrical circuits, smoke pipes, matches, clothes over stoves, electric irons, waste baskets, cigarettes, pyroxylin toys, oil mops, concealed spaces under the sink, etc. An important development which gave this campaign even greater force was the public endorsement of it when its director received a civic award.

Fire Department Coöperation.

Just a few of the methods which have been used by fire prevention bureaus with the coöperation of local newspapers in getting their important message to the local public are mentioned in this article. The inauguration of such coöperation was made the subject of a round table discussion at the annual meeting of the National Fire Protection Association in 1933. John W. Strohm, then Fire Marshal of Iowa, made some important suggestions for the dealings of the fire department with the local press. He advised that a single person handle the news stories. It would be his duty to give the correct facts of fires and other fire department affairs to the newspapers. That, according to Mr. Strohm, is the way to put the press in a good frame of mind toward the department. A tip on something of news importance, not necessarily connected with the fire department, fosters the friendly relations. Then the stage is set

Multitude of Fire Hazards Found in Kitchen of House

This is another in a series of weekly articles for Junior Fire Fighters, arranged by Park L. Roberts, director of fire prevention education.

IN the kitchen of every house there is a heating unit used every day throughout the year to cook food. In most houses, the fuel burned in the stove is such that a flame occurs. So it is in the kitchen that every day we have an opportunity to do some careless act which will result in that fire becoming uncontrolled.

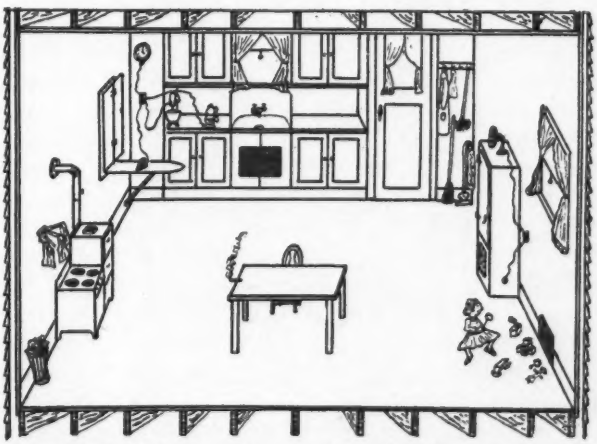
Records reveal that the kitchen is the source of disastrous home fires second only to the basement. In making a careful study of those records, however, we are amazed to learn that a large proportion of disastrous kitchen fires are not directly traceable to that flame utilized in the kitchen cook stove. On the contrary, many of them result from other hazards present in the kitchen which are not generally recognized as dangerous.

Today we are using in connection with this column a cut picturing a number of the most common fire hazards present in the kitchen. Each of them has been responsible for many disastrous home fires.

The cuts used in this column each week are duplicates of stereopticon slides made of each room in an average house. The slides are used for the instruction of members of the Junior Fire Fighters Clubs in their school meetings.

Each of seven rooms will be illustrated and discussed in this column on two successive Sundays. On the first Sunday the cuts are to be printed with a short comment, as is this one. Then, on the following week, the same cut will be printed with a detailed explanation of each of the fire hazards pictured. Junior Fire Fighters will find these comments to their advantage in making the weekly inspections in their houses, which are required by our 1938 program to reduce fire loss in Akron.

Non-member readers are invited to send comments or questions relative to the columns and cuts which will appear here during the next 12 weeks. Next Sunday we will reprint today's cut and discuss each of the hazards shown in it.



How many fire hazards can you pick out in this kitchen? Check your findings with the picture next week.

for the entrance of a little publicity. Mr. Strohm listed the following types of publicity, with a recommendation that all material be sent to the paper well prepared and ready to be printed.

> "(1) The annual reports concerning fires in your city. (2) The schools you hold for firemen and how they are trained. (3) Perhaps a feature on 'A Week Around the Clock with a Fireman,' telling just what the fireman does. (This gives a chance to weave in some stuff about how the machinery is cared for, how the boys are trained, and in general to get across to the taxpayers the fact that your department is doing everything possible to give them their 100 cents worth of service for every tax dollar.) (4) Perhaps a feature on your oldest and youngest firemen. (5) Perhaps a feature on how many thousands of miles some of your equipment has run. (6) Fire Prevention stories — not only at Fire Prevention Week, but at Christmas time, July 4th and other periods throughout the year. Also, depending on the individual papers, pictures of the department and personnel."

The more these programs and their results are studied, the more evident it becomes that the lowest per capita fire loss of all our cities is found where fire department and newspaper, with the help of all other public minded organizations, work together towards fire prevention education.

Another Red Menace!

Once again Fire Prevention Week is bringing home to us the facts regarding the **RED MENACE OF FIRE.**

Ghastly as are the figures revealing its annual toll, the knowledge that 80 per cent of **ALL** fires are **PREVENTABLE** makes them even more terrible.

Well, what **ARE** we going to do about it? Will 10,000 lives be lost and half a billion dollars go up in smoke **AGAIN** this next year?

The Los Angeles "Examiner."

Miami Municipal Airport Hangar Fire.

Shortly after midnight on April 2, 1938, fire completely destroyed an airplane hangar filled with costly airplanes at the Miami, Florida, Municipal Airport. The loss to the building was about $20,000, and to airplanes about $340,000. The cause of the fire is not known.

The hangar was one story in height with non-bearing concrete block walls, concrete floor, and wood sheathed roof supported on unprotected steel trusses. It was 125 ft. long, 75 ft. wide, and had an average height of about 20 ft. It was operated by the City of Miami for storage of private airplanes, with a moderate amount of service and with a small office on a balcony floor adjoining one side of the building. On the night of the fire the hangar was filled to capacity with eight or ten planes, practically all of which had full tanks of gasoline. The building was not equipped with an automatic sprinkler system, and the only water supply was one well about 150 ft. from the hangar with a capacity of about 600 gallons per minute.

Two mechanics had put their tools away after finishing repair work on a plane parked outside the hangar, and the watchman had just closed the doors to the hangar and walked to the gate house about 200 ft. from the hangar. Noticing flames through the glass windows, the watchman returned and attempted to extinguish the fire with first aid equipment, but realizing that he could not do it alone, he telephoned the director of aviation, who in turn called the Miami Fire Department. The watchman also called the Hialeah Fire Department about four miles away. This department arrived first, as it was a 12-minute run for the Miami department.

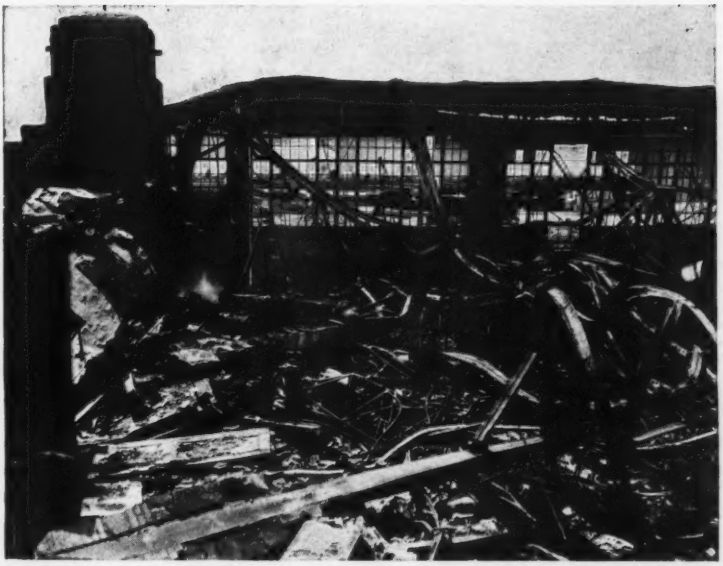
Explosions of the gasoline tanks of the burning planes aided in spreading the fire rapidly to all parts of the building. The burning gasoline and fabrics created such intense heat and large volumes of smoke and gases that firemen were unable to check the fire. The fire was fought by three hose streams from the well, and while this well proved to be all that could be expected of it, the fire departments were seriously handicapped by the lack of sufficient water. The unprotected steel roof trusses buckled under the intense heat and pulled down part of the walls as it fell. The blaze was not extinguished until about eight hours after it started.

The fire started in one of the airplanes. The cause was not determined. It is reported that the hangar and repair sections were well arranged and care-

NOTE: This account has been prepared from a report issued by the South-Eastern Underwriters Association (Member N.F.P.A.), from data supplied by Chief H. R. Chase of the Miami Fire Department, and from other sources.

International.

Fire destroyed this hangar at Miami, Fla., and the valuable airplanes stored in it, shortly after midnight on April 2, 1938. The water supply was inadequate and there was no automatic sprinkler system.



International.

Twisted structural members and débris are all that remain of this airplane hangar and about ten valuable airplanes which were stored in it at the time of the $360,000 fire on April 2, 1938, at the Miami Municipal Airport.

fully maintained. Among the several factors responsible for the rapid destruction of this property, the inadequate water supply, and the lack of automatic sprinkler protection are probably the most important.

About ten valuable airplanes were in the hangar, among which were a record holding Seversky pursuit ship and a Lockheed Electra which was used by Jimmie Mattern in his search for the lost Russian polar fliers last year. The hangar and airplanes were a total loss, amounting to about $360,000.

Fire destroyed this hangar at Miami, Fla., and the valuable airplanes stored in it, shortly after midnight on April 2, 1938. The water supply was inadequate and there was no automatic sprinkler system.

Terminal Hotel Fire, Atlanta, Ga.

Report by South-Eastern Underwriters Association,
(Member N.F.P.A.)

The worst hotel fire tragedy in the United States since the burning of the Windsor Hotel in New York City nearly 40 years ago took place in Atlanta, Ga., on May 16, 1938. An early morning fire starting in the basement swept the Terminal Hotel. Thirty-five of its 65 occupants were killed and many others injured. The building was of five-story brick joist construction with unprotected elevator and stair shafts extending from the basement to the top floor. The fire department responded immediately upon discovery of the fire, but upon arrival the fire had already reached such intensity in the upper floors that little rescue work could be done. The fire resulted in a total loss to the building.

Construction and Occupancy.

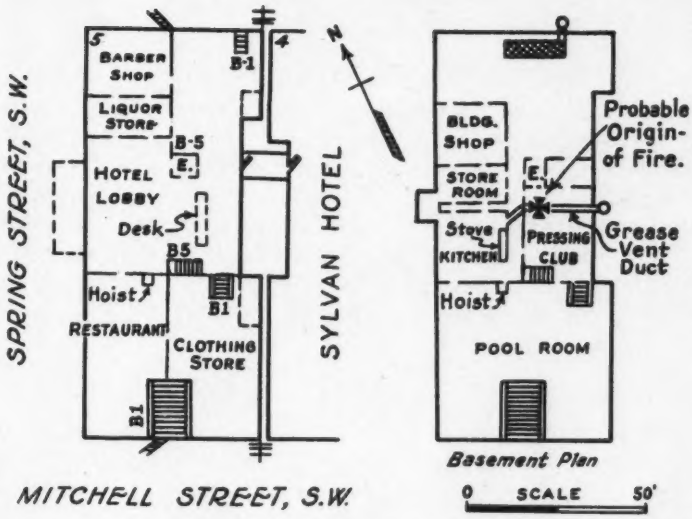
The building, located in the congested business district, was erected in 1908. According to the present building inspector, who was an assistant inspector in 1908, the building code in effect at the time did not permit a building of this construction and occupancy over four stories in height. By a special ordinance the city council permitted the erection of this building of excess height.

The hotel covered approximately 5000 square feet of ground area. Combustible interior construction, besides ordinary joisted floors and roofs, included wooden lath and plaster partitions and composition board on wooden studs. The single elevator shaft was partly enclosed by wooden lath and plaster partition on three sides, but had an open metal grillwork on the fourth side. There was an unprotected stairway extending upward through the building. There was a small hoistway from the basement kitchen to a restaurant on the first floor.

The basement, where the fire started, contained a pool room, pressing club, kitchen and storeroom for the restaurant, building maintenance shop, boiler room, and other service rooms. The first floor contained a restaurant, clothing store, liquor store, barber shop and hotel lobby. Above the first floor were guest rooms.

Discovery of the Fire.

Two restaurant employees were in the basement and four hotel and restaurant employees were on the first floor when the fire started shortly after 3 A.M. There were also at least two customers in the first floor restaurant.

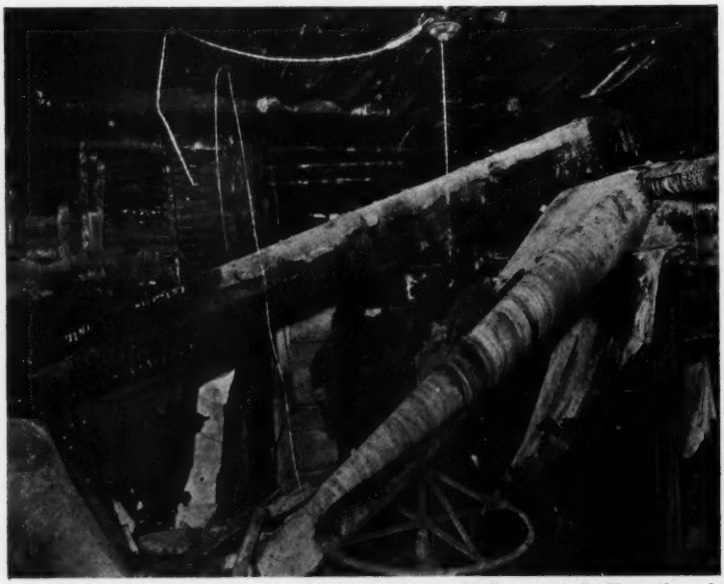


First floor and basement plans of Terminal Hotel.

Although there was some conflict in minor details, the testimony of the employees and customers was essentially concurrent in the following: One kitchen employee in the basement had gone to the restaurant storeroom through a passageway extending under the sidewalk. Upon his return, not over ten minutes later, the employee found smoke issuing from the ceiling in the small hallway just outside the kitchen door. He immediately went upstairs through the lobby into the restaurant and notified the restaurant operator, who returned with him to the basement. At the same time smoke was noticed in the restaurant from the kitchen hoistway.

When the men returned to the basement the smoke was extremely dense and the restaurant operator immediately returned to the restaurant and then went to the fire alarm box across the street with the restaurant customers, who turned in an alarm. The kitchen employee made his way out through on opening in the north wall of the basement. He had to break two locks and when he reached the alley the fire department had arrived.

The other kitchen employee was in the basement but was vague as to his exact location. He first saw dense smoke outside the kitchen door and attempted to get his clothes, located in the northeast portion of the basement. He returned to the hallway between the kitchen and pressing club but found flames in the ceiling of the hall, ceiling and floor of the kitchen, and found the



The interior of the pressing club room, where the fire started. Note the collapsed grease vent duct, which extended across the room from the kitchen range.

grease vent from the kitchen stove red hot. When he escaped to the alley to the north the fire department had arrived.

The hotel clerk and elevator operator were in the lobby when their attention was attracted simultaneously by the restaurant employees and smoke from the floor near the clerk's desk. The hotel clerk attempted to notify the fire department and guests by telephone and sustained some burns before leaving. The elevator operator took the elevator to the basement and discovered dense smoke and flame. He started the elevator to the upper floors to warn guests, but it stopped between the first and second floor level and the operator was forced to leave.

Loss of Life.

According to the chief of the fire department and several witnesses, when the fire department arrived dense smoke surrounded the building and flames were issuing from several windows on upper floors. Occupants were jumping from windows on upper floors, but due to dense smoke it was impossible to see the exact location from which they came and nets could not be used successfully. The first efforts of the fire department were concentrated on such rescue work as was possible under the circumstances and several occupants were brought safely down fire department ladders.

Interior of the Terminal Hotel after the fire which cost thirty-five lives. Several persons in the south portion of the building, shown in the background, lost their lives by suffocation rather than by flames.

The centrally located interior unenclosed stairway and elevator shaft were involved early in the fire and rendered useless. One open fire escape was located on the north side and one on the south side of the building, extending from the second to the fifth floor levels. These fire escapes passed directly by unprotected window openings and although of some assistance in rescue work they were involved in the early stages of the fire and not effective as a means

of egress. In addition to the thirty-five lives lost, several other persons were severely burned or injured by jumping. A number of bodies were removed in an unburned condition, indicating that death had been due to suffocation.

Fire Extinguishment.

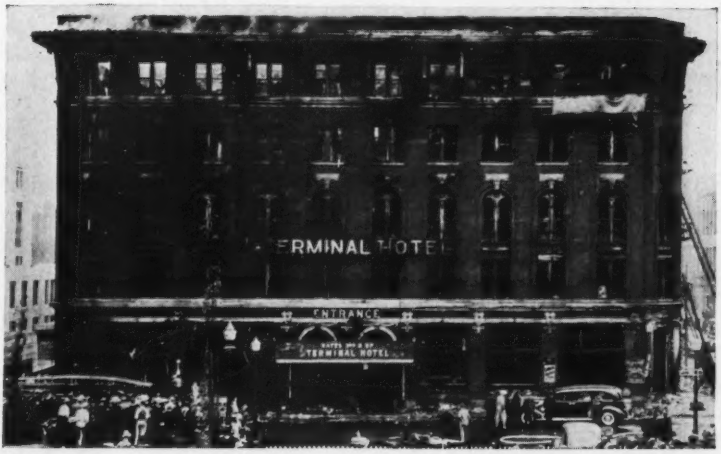
The first alarm was received at 3:15 A.M. over the fire alarm system. Four pumpers, two aerial ladder trucks, one service ladder truck, one rescue squad wagon and a water tower responded under the command of the chief and one assistant chief. Additional alarms, including a general alarm, brought a total of eighteen pumpers and eight ladder trucks to the scene. Off shift firemen were called for duty either at the fire or to man spare apparatus at vacated stations. Apparatus from Fort McPherson and Fulton County moved into the city for response to a second fire, and one Fulton County pumper responded to the hotel fire.

Hose lines were promptly laid and the fire was fought from the street and from the adjoining Sylvan Hotel. Due to the headway and intensity of the fire on arrival of the department, no lines could be carried into the building. Eleven pumpers supplied a total of 32 hose lines. A water tower, ladder pipe and two deluge nozzles were used. The water supply was adequate and uninterrupted.

The fire was confined to the building of origin and by 6 A.M. had been controlled to such an extent as to permit the removal of bodies from the south portion of the building, which did not collapse. One person removed at this time from the south portion of the second floor was still alive. By about 9 A.M. the fire was practically extinguished.

Origin of the Fire.

The exact origin of the fire has not been determined. The search for bodies necessarily disturbed a great portion of the débris, and the volume of débris precluded early observation of many areas. While not necessarily conclusive, it appears highly probable that the fire originated in the north portion of the pressing club, either inside the room or in a concealed space in the wall or ceiling. Fire evidently smouldered for a considerable period of time before discovery, sending hot gases to the upper floors through unprotected openings in the elevator shaft. A horizontal metal grease duct from the kitchen range crossed the pressing room about six to twelve inches from the ceiling. When the fire gained sufficient headway, grease in the horizontal duct was ignited, generating sufficient heat to ignite additional woodwork, creating a large volume of smoke and igniting the accumulated preheated gases on the upper floors. After the fire was extinguished, it was noticed that the first floor timbers over the grease vent in the pressing room were practically burned in two inside of the pressing room, but the timbers over the grease vent pipe in the hallway



Acme.

Little more than the outside walls remained of the death trap hotel following the fire. When constructed thirty years ago the building exceeded the height limitations imposed upon such combustible structures by the local building laws.

outside of the pressing club showed only slight fire damage. Likewise the north partition of the pressing club was much more seriously burned on the inside than on the outside, indicating that the fire started in the pressing club. The south end of the basement in the pool room showed practically no fire damage. The kitchen vent fan over the doorway into the hallway was distorted, but motor leads were intact, although charred. Motor windings were intact and did not indicate severe fire damage.

Conclusions.

This fire is another example of the large life and property loss which may occur in buildings of this construction and occupancy, even though under good public fire protection. It appears that the greatest contributing factor in this disaster was the inherent construction of this multiple-story, unsprinklered building, having wooden joisted interior and unprotected stairway and elevator shafts. Lack of automatic sprinkler and automatic fire alarm equipments, together with inadequate exit facilities, also contributed to the disaster.

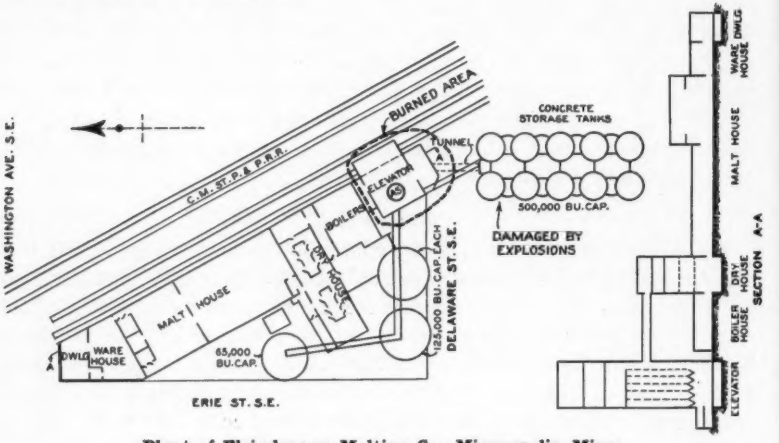
The property loss from this fire exceeded $125,000. This included $7500 water damage to the adjoining Sylvan Hotel and loss to the various tenants of the Terminal Hotel.

Important Aspects of Recent Explosions.

By David J. Price, Hylton R. Brown, and Paul W. Edwards.*

In the study of dust explosions in industrial plants it is always interesting to review new facts developed in connection with the investigations conducted to determine the cause of recent explosions. This is particularly true when the investigation corroborates the results of experimental or laboratory research work. Several recent explosions, in March and April, 1938, have occurred in industrial plants and under conditions which permitted a check on the value of a number of the safety measures developed by the Chemical Engineering Research Division of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, and recommended by the Dust Explosion Hazards Committee of the National Fire Protection Association in the safety codes for the prevention of dust explosions.

In this brief summary of recent dust explosions an effort has been made to direct particular attention to the factors or conditions which contributed to the explosion and the safety measures which might have served to prevent the ignition or reduce the hazard.



Plant of Fleischmann Malting Co., Minneapolis, Minn.

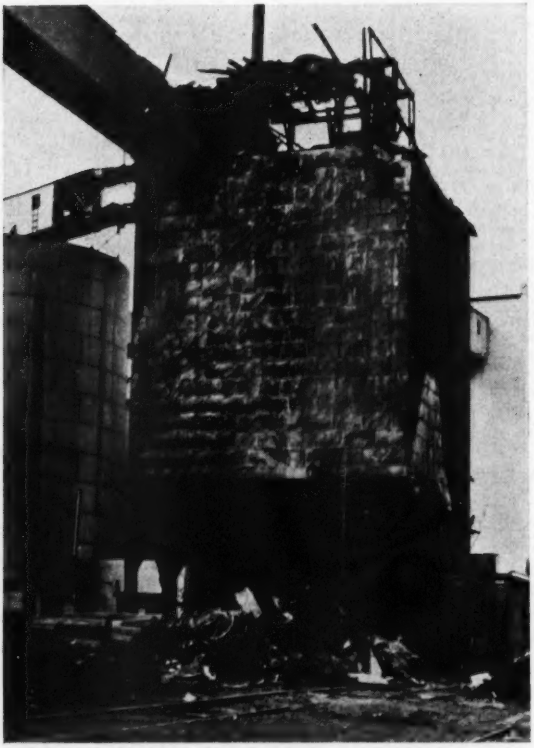
*Dr. David J. Price (Member N.F.P.A.), Chairman of the N.F.P.A. Committee on Dust Explosion Hazards, is Principal Engineer in Charge of the Chemical Engineering Research Division, Bureau of Chemistry and Soils, United States Department of Agriculture. Mr. Hylton R. Brown, Secretary of the N.F.P.A. Committee on Dust Explosion Hazards, is Senior Engineer, and Mr. Paul W. Edwards, Chemical Engineer, in the same Division. The publication of this article in the N.F.P.A. QUARTERLY has been authorized by the U. S. Department of Agriculture.

General view of the $200,000 fire which followed a dust explosion at the Fleischmann Malting Company. Fire quickly consumed the upper part of this old wooden section. The explosion ruptured the sprinkler system so that it was of little value.

Fleischmann Malting Company.

Minneapolis, Minn., March 22, 1938.

Two men were killed and six men injured by the explosion which occurred in this grain elevator during the handling of rye screenings. The property loss was estimated to be about $200,000. One of the men killed was superintendent of the plant, the other was a member of the state weighmaster's office. Two



The old wooden, metal-clad grain elevator section of the Fleischmann Malting Co., which was almost completely destroyed.

sections of the plant were involved: the old wooden, metal-clad grain elevator of crib construction, and the recently built concrete storage section of 500,000-bushel capacity. The general arrangement and location of the plant are shown in the diagram.

Operations at Time of Explosion.

When the explosion occurred only one operation was in progress. Material designated as rye screenings, which consisted of dust and light matter collected at the cleaners, as well as sweepings from around the elevator, had been stored, as was customary, in the bin at the southwest corner of the old wooden elevator. According to statements of employees there was about 33 feet of this material in the bin. A car had been spotted on the track beside the elevator and loading was in progress. For this operation it was necessary to attach a spout to the

bottom of the bin to carry the material to the boot of one of the three wooden elevator legs installed in the house. All three legs were in operation because they were connected to the same power line. The center leg was the one used to elevate the screenings and the others ran idle. After elevating, the material passed through the garner and scale, where it was weighed and then dropped through a loading spout on the outside of the building to the car below. No other equipment in the house was operating. The belt in the tunnel between the elevator and the storage section had been operated during the morning, but that was several hours before the explosion. There was no elevating or cleaning equipment in the storage sections, and the transfer belts had not been operated for some time.

Story of the Explosion.

The loading of the car of screenings had been proceeding in the usual way. An open trough metal spout was used to carry the material from the bin to the floor openings through which it flowed to the boot of the elevator leg. Loading of this material was evidently a dusty operation, and the open trough spout permitted the forming of heavy dust clouds on the first floor. Difficulty was frequently encountered in getting the material to flow from the bin.

About 71,000 pounds of the material had been run into the car and it was decided to load 4000 pounds more. About 3500 pounds of the 4000 needed was in the scale hopper when the flow became very slow and investigation showed that the material was not flowing from the bin. In order to loosen it or start it flowing, one of the employees on the first floor began to strike the bottom of the bin with a piece of 2 x 4 in. timber. The material evidently had arched or packed rather high in the bin and the employee reported that the last blow with the 2 x 4 apparently jarred this material loose, because he heard a peculiar thud, and then the bin bottom blew out and pinned him to the floor. Fire seemed to flash all around him immediately and before he could escape from the building he was painfully burned on the face and arms.

The employee on the scale floor about 85 feet above the first floor reported that fire suddenly appeared all around him and the flames seemed to come up through the floor. Fortunately the automatic sprinkler system operated and thoroughly wet his clothing. Although painfully burned by the first flash, his clothing did not burn and he was able to escape from the building by sliding down a pipe to the gallery which led to the malt house.

Cause of the Explosion.

Fire which followed the explosion and the collapse of large sections of the structure destroyed any evidence which might have been present to indicate the exact cause of this explosion. The statements of the employees indicate very definitely the conditions existing at the time and explain clearly how the dust cloud was formed. The loading of the screenings would normally be a dusty

The tops of the new concrete storage tanks were blown off by the explosion. The heaviest damage was in this section of the plant.

operation and the sudden release of a quantity of the screenings and dust lodged high in the bin would produce an unusually heavy cloud of dust as it struck the bottom of the bin.

Some of the investigators and some of the employees are of the opinion that metal objects in the dust struck the metal-lined bin bottom or the metal spout when the mass of dust lodged in the upper part of the bin and a spark produced in this way ignited the dust cloud. This is quite possible and should be considered as a probable cause, since metal objects are frequently found in material of this kind.

Consideration also should be given to the fact that there was about 10,000 pounds of material stuck in the bin, probably 20 or 25 feet above the bottom. The impact of this falling mass on the bin bottom would be capable of tearing the hopper loose from the bin walls, and in falling to the floor the hopper may have broken electric wiring, which produced an electric spark and ignited the dust. The report, which indicated that the lights went out immediately, strengthens this theory.

Damage to Storage Section.

The principal object lessons found in the investigation of the explosion were in the storage section. Although no equipment was operating and it was reported to be in clean condition, the heaviest property loss occurred in this section. There must have been sufficient dust present below the tanks to form an explosive mixture which was ignited by the flash that came through the tunnel from the old elevator, because the pressure produced at this point was sufficient to force upward the hopper bottoms of all bins not loaded with grain.

These hoppers were torn loose from the side walls and in many cases the roof slab over the bins was blown off. Windows were blown out and some walls were cracked, which indicated that the amount of vents provided was not sufficient to release the pressure before structural damage occurred.

Recommendations.

In the building or rebuilding of a grain elevator it is recommended that all possible precautions be taken to eliminate possible sources of dust ignition, and to provide for the release of pressure should an explosion occur.

Attention is called to the suggestions covering new elevator construction made by the Dust Explosion Hazards Committee of the National Fire Protection Association in the safety code for the prevention of dust explosions in grain elevators.

Special attention should be given to the location of dust bins and dust-collecting equipment.

Large window areas with top-hinged sash to provide 1 sq. ft. of venting area for each 80 cu. ft. of volume should be provided for the release of pressure wherever the dust explosion hazard exists in grain-handling plants.

New Orleans Public Elevator.

New Orleans, La., April 4, 1938.

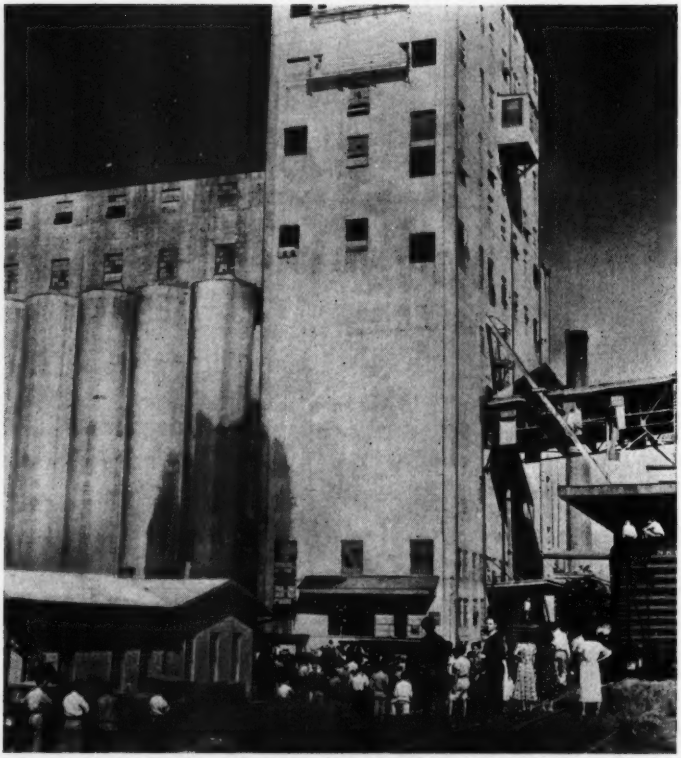
Six men lost their lives and 16 others were injured as a result of a dust explosion at this plant during the handling of corn. One of the men who died as a result of burns received in the explosion was a member of the Federal Grain Supervision force of the U. S. Department of Agriculture. Another victim of the explosion was an employee of the New Orleans Board of Trade. The elevator, a fire-resistive structure of concrete and steel, was only slightly damaged because it was maintained in a clean and orderly condition, had large window areas which served as explosion vents, and contained many other protective features recommended by the Dust Explosion Hazards Committee of the N.F.P.A. The property loss of about $20,000 is comparatively small for a plant of this size with storage capacity of more than 2,500,000 bushels.

Operations at Time of Explosion.

The elevator had been operated continuously since November 17, 1937, with the exception of two holidays, because of the heavy movement of corn export shipments through this port.

At the time of the explosion four separate operations were in progress:

1. Corn was being unloaded from a barge tied up at the marine leg and transferred through the gallery to a receiving bin just inside the workhouse. From this bin it flowed through a round metal spout to within about 5 feet of

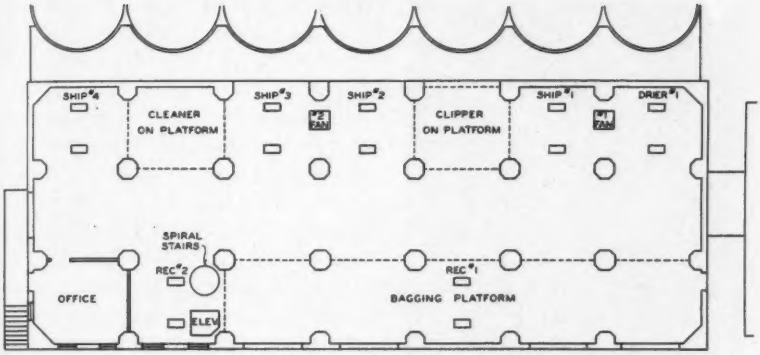


General view of the workhouse at the New Orleans Public Elevator after the explosion on April 4, 1938, which killed six men and injured 16 others.

a grating on the workhouse floor over the entrance to the boot of an elevator leg designated as Shipper 2. The spout was elevated above the grating so that the corn would fall in a free stream to permit sampling by the federal and board of trade inspectors. After entering the boot the grain was elevated and passed through a garner and scale on to a distributing belt which carried it to a storage bin.

2. Corn was being unloaded from cars in the track shed and passed through the pits or track hoppers on to a belt in the tunnel which carried it to the boot of an elevator leg, designated as Receiver 1. From this point it was elevated to the top of the house and passed through a garner and scale on to transfer belts which carried it to a storage bin in the annex.

3. The third operation was similar to the second. Corn from the cars being unloaded in the track shed was brought into the house on another one of the belts in the tunnel and elevated by another one of the receiving legs, desig-



First floor plan of workhouse, New Orleans Public Elevator.

nated as Receiver 2, to the top of the house. After passing through a garner and scale this particular lot of corn was carried on distributing belts to a storage bin in the annex.

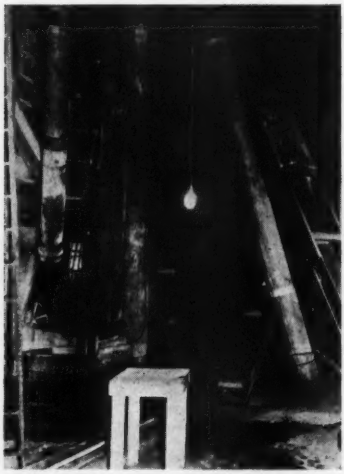
4. The fourth operation consisted of the transfer of corn from the drier to the workhouse, where it was elevated by the drier leg and after weighing transferred to a storage bin. The best information available indicated that this operation had been stopped just before the explosion occurred.

A careful check of these operations indicates that the only one in which grain was actually flowing at the time of the explosion was the transfer of corn from the barge. In the other cases the flow had been stopped temporarily to move new cars into position for unloading. It is known definitely that corn was still flowing from the elevated spout on the first floor of the workhouse, where the grain samplers were working.

Story of the Explosion.

This explosion occurred during the normal operation of the plant without warning of any kind. Employees were engaged in their regular occupations at different points in the house. Eye witnesses reported seeing a flash or ball of fire at one end of the first floor of the workhouse in the vicinity of Shipper 1 and then the ignition of the larger dust cloud around Shipper 2. Flames immediately flashed through the house. The fire department was called at once and responded promptly, but there were only a few small fires in dust collectors and among stored sacks to be extinguished. Attention was directed to the rescue and care of injured employees and ones trapped on the upper floors. Ambulances rushed the injured to hospitals.

An examination of the damaged elevator corroborated the statements of eye witnesses by indicating quite definitely that the major explosion centered



An interior view of the first floor of the workhouse after the explosion.

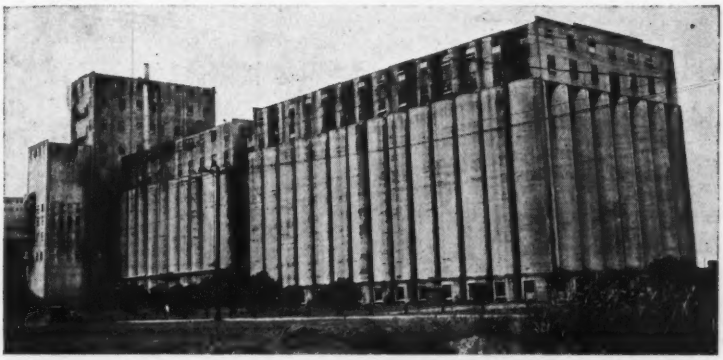
around the point on the first floor where the corn coming into the house from the barge was being sampled. There was also considerable evidence to show that the explosion had traveled downward from the first floor into the basement and upward through elevator legs and stairway to the top of the house. Undoubtedly there were a number of minor explosions as the flames flashed through the house. Some of the steel elevator legs were damaged very little, while others were bulged or had some of the plates blown off. One concrete wall of the well in which Receiver 2 operated between the first floor and the bin floor was ruptured. This was the only structural damage. Some windows were blown out and a number of the corrugated iron plates on the side of the shipping gallery were blown off. The open type of construction permitted quick venting of the explosion pressure and prevented propagation into the annex or for any great distance along the shipping gallery.

Cause of the Explosion.

Statements were taken from all employees and their stories, together with the evidence found in an examination of the plant, indicated that the explosion occurred when the dust cloud present on the first floor was ignited by a flash in the northeast corner, apparently between Shipper 1 and the drier leg.

With these clues, search for the cause of the original ignition was concentrated in this section. All equipment was carefully examined, including the fan of No. 1 dust collecting system, which had been located on an overhead platform between Shipper 1 and the drier leg. It was ascertained that the motor which had been connected to this fan was the only one found to be damaged after the explosion and it had been removed to a repair shop for overhauling.

It was learned that this motor, a 35 H.P. 440-volt, 900 R.P.M. induction motor, had been overhauled in January and after new bearings were installed tests showed it to be in good condition. After the explosion, tests showed a full ground in this motor and it was sent to the shop for repairs. Examination there disclosed a definite short and burns on the stator coil. One of the windings had grounded and fused for about ½ inch.



The 2½-million-bushel New Orleans Public Elevator, where six men were killed.

Subsequent examination at the plant disclosed evidence of additional arcing in the motor control equipment. Insulation failure had occurred in the overload relay case. This equipment was also located on the first floor in the section where the first flash was noticed. Either this arc or the one in the motor would be capable of igniting a dust cloud, and it is quite evident that a heavy dust cloud was present. It seems most reasonable to assume that the arc in the motor was the one which caused the first ignition of near-by dust and this flash produced the larger explosion which centered around Shipper 2.

Lessons from the Explosion.

This explosion has corroborated many of the findings in the experiments conducted by the Chemical Engineering Research Division of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, at its Dust Explosion Testing Station at Arlington, Va.

1. The exceptionally small property damage proved the actual value of many of the safety measures recommended for protection against dust explosions.

2. Open type construction with plenty of venting area and the abolition as far as possible of underground basements and tunnels undoubtedly reduced the extent of the property damage.

3. The high basement with large window areas was effective in limiting the propagation of the explosion.

4. The use of steel grating floors in the upper part of the house prevented the building up of excessive pressures in any one section of the plant and also prevented large accumulations of dust at points where it might have been thrown into suspension and produced additional heavy explosions.

5. The general application of suction throughout the plant reduced the

amount of dust in suspension, and the floor sweep system provided a ready means of disposing of static dust accumulations which might otherwise have contributed to the spread of the explosion.

6. Although the property loss was small, the loss of life and the large number of person injured indicate the need of increased activity in the work being done to eliminate this hazard.

7. The investigation brought out the value of instructing employees concerning the dust explosion hazard. Many of the older men remembered the dust explosion demonstrations given at such plants in 1918 and 1919 in the special dust explosion prevention campaign. The great number of new men who have entered the dust-producing industries since that time is an incentive to increase the activities designed to instruct employees of such plants on methods of preventing dust explosions.

Recommendations.

1. Motors and electrical equipment selected for this plant in 1917 were probably the best and safest types available at that time. Much of this equipment served for 21 years without causing any serious trouble. In this period improvements have been made and it is now possible to obtain explosion-proof motors and improved electrical equipment which is recommended for locations where a dust explosion hazard exists.

2. The dust collecting system in the New Orleans elevator was more extensive and complete than is generally found in grain elevators, but the fact that an explosive dust and air mixture occurred during the normal operation of the plant indicates the necessity of giving further attention to the development of dust control equipment for grain elevators. Suction should be applied for dust removal at every point where grain is turned or thrown.

3. To completely eliminate the dust hazard it will be necessary to discontinue any grain handling process which throws clouds of dust into the air at points where dust collecting equipment cannot be used. It is especially recommended that the use of open spouts or screen spouts within an elevator be discontinued.

Ralston Purina Company.

Nashville, Tenn., April 29, 1938.

A dust explosion occurred in this plant at 4:17 P.M., April 29, 1938. Only the reinforced concrete elevator section was involved in the explosion. There was not much fire after the explosion and apparently most of it was in the grain bins. Eleven men were burned or otherwise injured. The loss was estimated to be about $85,000, of which at least $60,000 consisted of damage to the building and $25,000 loss to the stock.

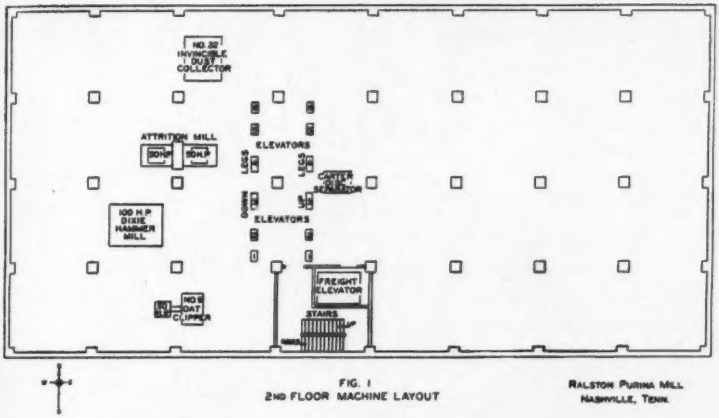


FIG. 1
2ND FLOOR MACHINE LAYOUT

RALSTON PURINA MILL
NASHVILLE, TENN.

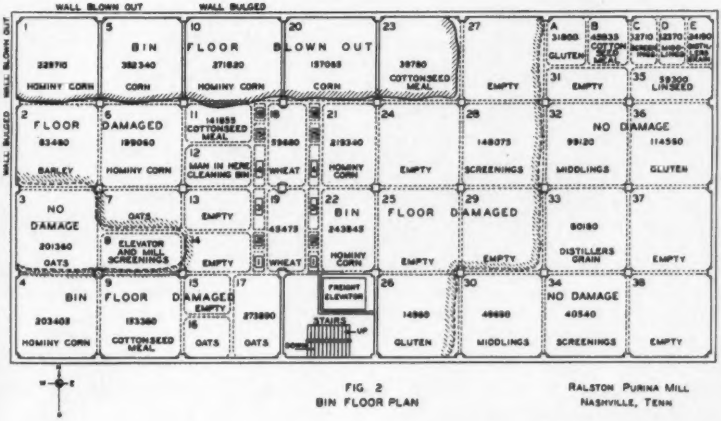


FIG. 2
BIN FLOOR PLAN

RALSTON PURINA MILL
NASHVILLE, TENN.

Description of the Plant and Equipment.

The six-story and basement reinforced concrete structure in which the explosion occurred is about 50 x 100 ft. and 170 ft. high. It contains 43 bins between the second and third floors, arranged as shown in Figure 2. There is the usual installation of garners and scales and cleaning machinery. In addition there are attrition and hammer mills, an oat clipper and cleaning machines on the second floor. (See Figure 1.) The plant is served by six steel bucket elevators grouped in a row across the building from north to south and about 30 ft. from the west wall.

The bins are covered by a concrete slab which serves as the bin floor. There are openings between inner and outer bins directly under the bin floor

Eleven men were injured and damage of $85,000 was done by the corn dust explosion at this reinforced concrete plant of the Ralston Purina Company.

designed to serve as vents. Where the elvator legs pass through the bins they are in reinforced concrete wells.

Operations in Progress.

At the time of the explosion the following operations were in progress:

1. A car of corn was being unloaded into the receiving pit. This operation evidently was almost completed, for two employees had just stepped out of the car to get brooms when the explosion occurred. This was the second car of corn unloaded that afternoon. From the receiving pit or "sink" the corn was carried by a short conveyor belt in the basement to the boot of elevator 3, then elevated and spouted to the scale hopper, but not weighed, and spouted directly to bin 10. Until about 15 minutes prior to the explosion the corn was spouted directly from the elevator to bin 10. According to statements made by employees, the corn, which contained 15.5 per cent moisture, was very dusty.

2. Clipped oats were being transferred from bin 17 to bin 7. The oats were spouted from bin 17 to the distributing bucket elevator No. 4, elevated, and then spouted directly to bin 7. This was a direct transfer without weighing.

3. Screenings were being ground in the hammer mill on the second floor. The screenings are spouted from bin 8, which is directly over the mill, and passed over a magnetic separator before entering the mill. The discharge from the mill is carried to a cyclone collector located outside on the south wall of the plant and then spouted to packers near the hammer mill. For a period of a month or more this mill had operated continuously, except for short intervals while screens were being replaced.

4. Broken cottonseed cake was being ground in an attrition mill on the second floor located directly under bin 12. The broken cake was spouted directly from bin 12 and passed over a magnetic separator before entering the mill. The ground meal passed through two short screw conveyors and a spout to the boot of elevator 6, which was used exclusively for cottonseed meal. The meal was spouted from the elevator head to a Rotex sifter located on the distributing floor and then carried by the north screw conveyor, located on the ceiling of the bin floor, to bin "B," which is a working bin for the feed mill.

An employee suspended by a harness was cleaning bin 12 at the time of the explosion.

Story of the Explosion.

The elevator superintendent, who was talking with the general superintendent on the loading platform on the west side of the plant directly above the receiving pit, stated that the first indication of the explosion was a flash from under the loading platform, quickly followed by another which was more severe than the first. After a very short interval he heard the débris from the bin walls striking the shed over the loading platform. He stated that the corn being unloaded was extremely dusty, and that he had been in the basement a short while before the explosion and found it very dusty, although the windows were open. Both he and the general superintendent were badly burned about the face, hands and arms by the two flashes. Two employees just inside the door were also burned by the initial explosion.

The west wall of the elevator between the loading platform and the shed roof was covered with charred dust, and the windows on the west side of the basement were blown out. It seems very probable, therefore, that the explosion propagated from the basement through the receiving pit and also through the windows, and was deflected by the freight car standing in front of the loading platform on to the platform where the men were standing.

An examination of the elevator legs showed that both up and down legs of elevators 3 and 4 were progressively damaged from the boots to the heads. There was very slight or no damage to these boots and casings in the basement; on the fourth floor the casings were ripped open, and the heads of legs 3 and 4 were blown apart. The vents on the heads of legs 3 and 4 were also blown off. The head of elevator 5 was blown open, but the casing was not damaged as

Explosion damage to bins and walls at the northwest corner of the bin floor.

badly as 3 and 4. The head of leg 6 was slightly bulged, but the casing was not damaged. The boots, casings and heads of legs 1 and 2 were not damaged.

The progressive damage from boots to heads of the elevators, particularly 3 and 4, indicates that the explosion must have propagated from the basement upward. From the legs it traveled to the bins. Since the bins were interconnected by small vents about 18 x 24 in. in size, the explosion propagated from bin to bin. The photographs show the damage to the bin floor and the outside walls.

The northwest portion of the elevator section suffered the most damage. Part of the north and west walls were blown out and other portions badly bulged.

Probably about 2/3 of the bin floor will have to be replaced. The damage to the floor varied, some sections were cracked, while others were blown out or badly bulged. (See Figure 2.)

An employee in bin 12 at the time of the explosion was not burned, but suffered from shock and lacerations due to being thrown against the bin walls, and probably from débris from the bin floor.

A flash from bin 22 seriously burned an employee standing in front of the freight elevator. The floor over bin 22, on which he was standing, was badly damaged.

This view of one part of the bin floor gives some indication of the extensive damage to the structure.

Employees in the office, which is located east of the feed mill, stated that they heard a number of explosions in very rapid succession. It is possible that part of the noise they heard was débris falling on the feed mill and the metal-clad shed on the west side of the plant.

The low air signal from the sprinkler equipment was received at the central station about 20 seconds before the alarm sent in by an employee. Four engine companies and one ladder company responded. Four hose lines were laid but not used. A booster line was used on fires in the bins, and the sprinkler system extinguished all fire in the sprinklered area.

A spectator was slightly injured when he entered the building with the firemen and fell or tripped over some equipment in the plant.

All reports and testimony indicate that the management kept this plant clean, which accounts for the fact that the damage was confined to bins and elevator legs.

Cause of the Explosion.

There are a number of possible causes for explosions of this type, such as: smoking or the use of matches; foreign material in the grinding equipment; defective electrical equipment; and foreign material or loose buckets striking sparks in the elevating equipment.

The Ralston Purina Company has very rigid rules regarding smoking and carrying matches and it is believed that these sources of ignition were not responsible for the explosion.

A careful investigation of the damage to both the building and the equipment, and the testimony of employees, indicated quite definitely that the explo-

sion originated in the basement and propagated through the elevator legs into the bins, where most of the damage was done.

It is believed that the explosion was caused by foreign material in the corn, which was being unloaded, striking the buckets or casing of the elevator. The sparks thus produced ignited the cloud of corn dust.

Recommendations.

The following recommendations, based on this investigation, are applicable to all plants of this character.

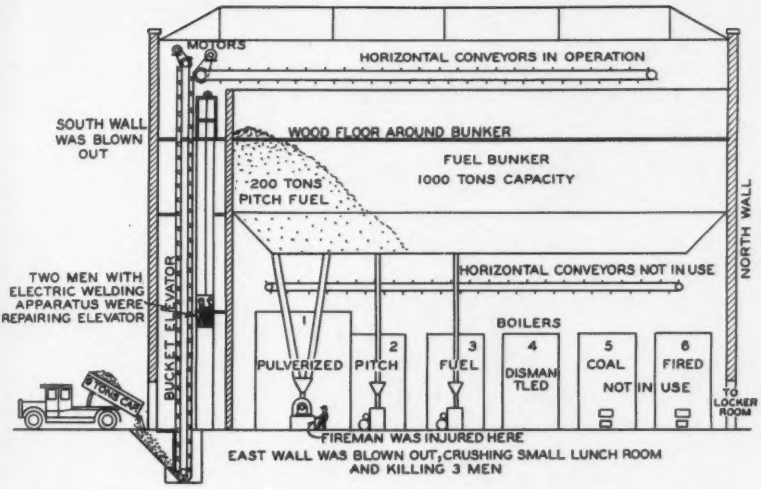
1. All openings between bins should be closed. All bins should be vented to the outside of the building. (See N.F.P.A. Code for the Prevention of Dust Explosions in Flour and Feed Mills and Terminal Grain Elevators.)
2. Suction should be applied to all incoming grain at the boots of the elevators. This will prevent, to a great extent, the accumulation of dust in the bins and elevator legs, and also help to eliminate the dusty condition in the basement when grain is unloaded.
3. A two-inch mesh screen, placed in the receiving pit, would remove foreign material more effectively than the larger mesh screens.
4. Larger venting areas could be obtained by replacing the present windows with sash hinged at the top.
5. Dust-tight globes with substantial guards should be installed on all electric lamps.
6. All electrical equipment should comply with the regulations of the National Electrical Code for use in dusty atmospheres.
7. All equipment should be grounded for the elimination of static electricity in accordance with the report of the N.F.P.A. Committee on Static Electricity.

Horton-Pilsener Brewing Company.

New York City, N. Y., March 4, 1938.

On March 4, 1938, about 1:24 P.M., an explosion occurred in the boiler house at the Horton-Pilsener Brewing Company plant, 461 West 128th Street, New York City. The explosion resulted in the death of five persons, injuries to seven others, and extensive damage to the building and equipment. The investigation of this explosion by the Chemical Engineering Research Division of the U. S. Bureau of Chemistry and Soils was made at the request of Chief Fire Marshal Thomas P. Brophy, in charge of the Bureau of Fire Investigation of the New York Fire Department.*

*During the course of this investigation conferences were held with George W. Jones, chemist of the Pittsburgh, Pa., Experiment Station of the U. S. Bureau of Mines, and M. J. Ankeny of the Safety Division in connection with the investigation of the explosion by the Bureau of Mines.



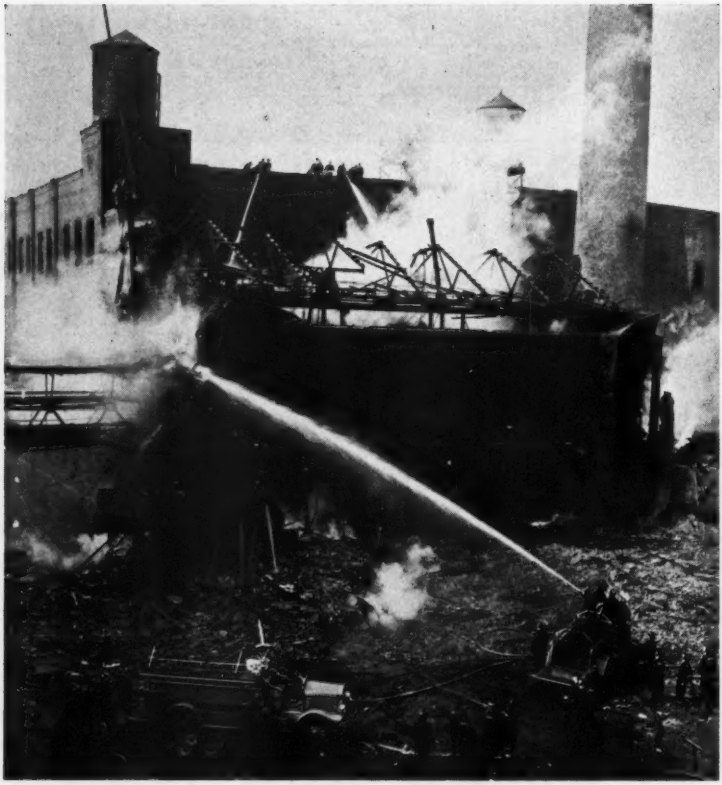
Boiler house of the Horton-Pilsener Brewery, New York City.

The explosion occurred during the elevating of coal tar pitch used for fuel from a delivery truck on the street level to the top of the storage bunker on approximately the fourth floor level of the building. The use of electric welding equipment during repair work on the elevator leg casing while the equipment was running was considered responsible for the ignition of the pitch dust cloud produced in connection with the unloading, elevating and storing operations. From the evidence available at the time of the investigation it would appear that there was no criminal negligence.

Description of Plant.

The boiler house was a brick building approximately four stories high with six boilers located on the first floor. At the time of the explosion there were three unit pulverizer systems installed. Number 1 unit pulverizer supplied both Nos. 1 and 2 boilers, while separate unit pulverizers were installed for No. 3 and No. 4 boilers. Numbers 5 and 6 boilers were of the regular coal-burning type.

The fuel was carried by means of a bucket elevator, with the receiving boot in the cellar pit and a horizontal conveyor on the fourth floor to a bunker of approximately 1000 tons capacity. The fuel was fed to the unit pulverizers from the bunker and blown directly to the boiler furnaces. At the time of the explosion unit pulverizer No. 1 was the only one in operation. (See diagrammatic sketch of boiler house.)



Acme.

Firemen fighting the fire at the Horton-Pilsener Brewery which resulted from two explosions of coal tar pitch dust. Five persons lost their lives.

Operations in Progress.

The explosion occurred while a truck of about nine tons capacity was unloading coal tar pitch from a near-by New Jersey plant. The fuel pitch is made by distillation of coal tar and is the residue of the process of distillation after all light oils and creosote oil are removed. The flaked product consists of small pieces resembling somewhat pea size anthracite coal.

The fuel was dumped from the truck on the street level into a cellar pit near the southeast corner of the boiler house. The pitch was being elevated from the cellar pit by means of the steel vertical elevator leg to the horizontal conveyor on the fourth floor level and then discharged into the bunker. It was the ninth load of nine tons each delivered the day of the explosion, and accord-

ing to information available the bunker contained approximately 200 tons of coal tar pitch.

The fuel was being fed from the bunker to unit pulverizer No. 1. This was the only boiler in operation at the time the explosion occurred.

Two workmen stationed in a passenger elevator and located at about the second floor level were making repairs to the casing of the vertical elevator leg. These repair operations, which were in progress at the time the explosion occurred, were for the purpose of preventing the escape of pitch dust through openings in the steel casing enclosing the elevator leg. Both oxyacetylene cutting and electric welding equipment were used to close these openings. From the investigation it appeared that the oxyacetylene cutting equipment was not in actual use at the time of the explosion, but that the electric welding operations were in progress.

Story of the Explosion.

Apparently there were two explosions followed by fire. The first ignition occurred at the point where the workmen were repairing the elevator leg casing. The explosion then propagated or spread either up the leg on the inside or through the dust cloud present in the boiler room due to escaping dust, or perhaps both ways to the dust cloud around the bunker on the fourth floor level. The second explosion occurred at this point, blowing out the east and south walls and causing the damage to building and equipment.

Cause of the Explosion.

The cause of the explosion was ignition of the coal tar pitch dust by an electric arc being used to weld the casing of the steel elevator leg. The workmen observed the ignition at this point and also the flash fire of the second explosion above the bunker on the fourth floor.

Tests in the Chemical Engineering Research Laboratory of the Bureau of Chemistry and Soils definitely indicate that the dust from the sample of coal tar pitch from the truck being unloaded at the time of the explosion is explosive when mixed with air in proper proportions. The pressures developed in this method of laboratory testing are about the same as those obtained with other samples of coal tar pitch previously tested.

Recommendations.

This explosion emphasizes two definite points:

(1) Repair operations of this character involving apparatus or equipment employing any kind of flames or sparks should not be permitted while elevating, conveying, storing, or other combustible dust producing operations are in progress. Equipment always should be shut down while repair operations are being carried on.

(2) Officials and employees engaged in the operation of industrial plants and equipment where combustible dusts are elevated or produced should be

fully informed on dust explosion hazards and the methods that should be adopted for their control and prevention.

Conclusion.

The investigation of this explosion definitely shows that repair operations of any kind in plants where explosive dust clouds are produced should not be carried on while equipment and apparatus are operating. The recommendations in the safety code for the Installation of Pulverized Fuel Systems, prepared by the Dust Explosion Hazards Committee of the N.F.P.A., should be followed in installations of this kind.

Sewaren, New Jersey, Tank Truck Fire.

By Charles G. Durfee.

On March 21, 1938, a tank truck loaded with 4990 gallons of gasoline was struck by a fast passenger train at a crossing in Sewaren, N. J. The truck, consisting of tractor and semi-trailer, was demolished and the gasoline ignited. In the cab of the locomotive, which was derailed, the fireman and engineer on the train were sprayed with burning gasoline and burned to death; the truck driver was critically burned.

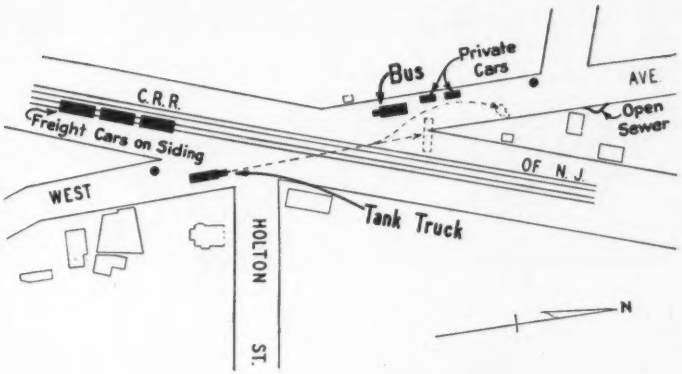
Story of the Fire.

The tank truck had just left a gasoline loading station and proceeded along West Avenue northward toward the railroad crossing (see diagram). When the driver reached the intersection he found that the warning light was turned on but the gates were open. There was a row of freight cars to his left and the acute angle at which the track crossed the road prevented him from seeing down the track in that direction.

Across the track from the truck were a bus and two private cars. These people, facing the track on the obtuse angle, had a good view of the approaching train. Although the bus driver tried to warn him, the oil truck driver, seeing the track to his right and not being able to observe the track to his left, proceeded across. His tractor had cleared the track and the trailer was across it when the impact came.

The gasoline tanks were ruptured and gasoline was thrown far and wide. The trailer was thrown to one side of the road not far beyond the track. The tractor, on the other hand, carried forward a considerable distance farther down West Avenue.

The gasoline flashed immediately, fatally burning the engineer and fireman. Other fatalities in the train might well have occurred except for two fortunate circumstances, one paradoxically being the high speed at which the train was traveling. Had the train been able to stop short it would have come



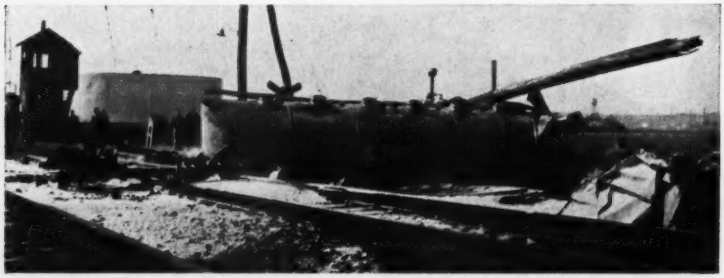
to rest in the midst of the fire area; had the weather been warmer possibly windows would have been open in the passenger cars, admitting the flame to these cars as the train rushed by. As it was, the train came to rest well out of the main fire area and the fire, which persisted on the outside, was quickly extinguished.

Serious Situation at Crossing.

At the crossing a very serious situation existed. The passenger bus had been struck by the trailer as it swung around and had been liberally sprayed with gasoline. The two private cars behind the bus were able to pull off the road into the adjacent field quickly and keep out of the way of trouble. The gasoline which flowed from the broken trailer began running down grade toward an open sewer. As it spread down the street blazing, it threatened a fenced field well grown with brush in which there was also a wooden shed. Beyond this brush field were the relatively close-placed houses of the town.

The driver of the passenger bus had five adults and fourteen school children on his bus. The whole side and rear of it were ablaze, making it wholly impossible to use the emergency rear exit door, and the force of the impact had jammed the normal entrance door at the right side. With calm and heroism the driver rode his bus across the track, out of the center of the fire zone, kicked his door open by lying on the floor and lashing out with both feet, and conducted his nearly hysterical passengers out. He then took his 1-quart vaporizing liquid extinguisher and extinguished the fire on the left side and rear of the bus so promptly that the damage was confined to a blistering of the paint only.

Meanwhile attempts to turn in a fire alarm had shown that the collision and fire had damaged the communication wires running adjacent to the railroad tracks, disrupting both fire alarm and telephone service in that vicinity. The manager of the oil station, however, and others knowing that one of the



This six compartment, semi-trailer tank, loaded with 4990 gallons of gasoline, was struck at a railroad crossing by a fast passenger train. The impact separated it from the tractor unit and released flaming gasoline that seriously threatened surrounding property. Note the foam from the extinguishers used on the fire covering the foreground.

oil trucks had just headed toward the intersection, hearing a crash, made an investigation and immediately transported a 40-gallon wheeled foam extinguisher to the scene of the fire. This was inadequate to cope with the tremendous blaze and they returned promptly to secure items of major foam apparatus from the plant. Meanwhile other alert individuals had proceeded on foot to one of the fire stations, which thus received the alarm only very little later than it would have received it through normal communication means. The Township of Woodbridge, of which Sewaren, New Jersey, is a part, has an alert and well-equipped fire department which coöperates with and receives fine coöperation from the industrial companies in their territory.

Upon arrival at the fire scene the fire department found West Avenue ablaze practically from curb to curb beyond the railroad tracks and blazing gasoline rapidly approaching the sewer opening. The fire in the gasoline was eating through the fence and threatening to sweep on across the habitations on that side of the road, and was also threatening the buildings adjacent to the other sidewalk line. The apparatus was quickly employed directing water streams at the exposed houses, and foam on the gasoline fire. The oil company's first generator was connected to a pumper to strike at the fire at the railroad tracks and the trailer. On another piece of fire apparatus the Woodbridge Fire Department air foam play pipe was brought into play to work up from the sewer opening and prevent the fiery flood from pouring into the sewer system.

The first chemical foam generator which was hooked up at the crossing was found to be inoperative, but a second one was secured, and working substantially in that same position it subdued and extinguished the fire on and around the trailer tank.

Meanwhile, with the air foam nozzle, the fire department swept out the fire in the streets before them and worked up to the tractor, and then to the trailer location, where they aided in the extinguishment of the last of the fire.

Showered with gasoline, the tractor blazed fiercely, though well separated from the tank unit. The driver was critically burned before he could escape.

The total property damage consisted of a loss of the gasoline itself, only some of which was consumed by fire, a few feet of fencing, the paint on one side of the passenger bus, and slight damage to the railroad coaches. The locomotive was seriously damaged by impact with the truck, but remained upright, though derailed.

While the immediate cause of this collision and fire was apparently the negligence of the railroad gate tender, who was reported to have left his post for a few moments to park his automobile, the resulting situation is one which might be duplicated in many ways. Constant training of drivers of oil trucks and other vehicles is necessary to keep them alert to avoid such serious accidents and fires.

In the record of this tragic fire, it is of great interest to observe how the excellent coördination of fire fighting facilities very probably prevented a major conflagration, and how the resourceful and intelligent action of the bus driver probably saved many of his nineteen passengers from death by fire or panic.

Fatal Fires in San Francisco, 1918-1937.

By C. Heller,
(Member N.F.P.A.)

Fatal fires may be divided into two main groups: those in which the victims are killed through some act of their own, by which they set their clothing on fire, and those in which a structure or its contents is first set on fire. In recent years the former type of fire has become the more frequent. Among its most common causes are smoking in bed, cleaning with gasoline, playing with matches, and coming in contact with an open flame. Life losses attributed to building fires include all cases in which the contents of a structure are ignited and people are killed by being trapped, burned or suffocated, or by panic. Practically the sole cause of self-ignition fires is carelessness.

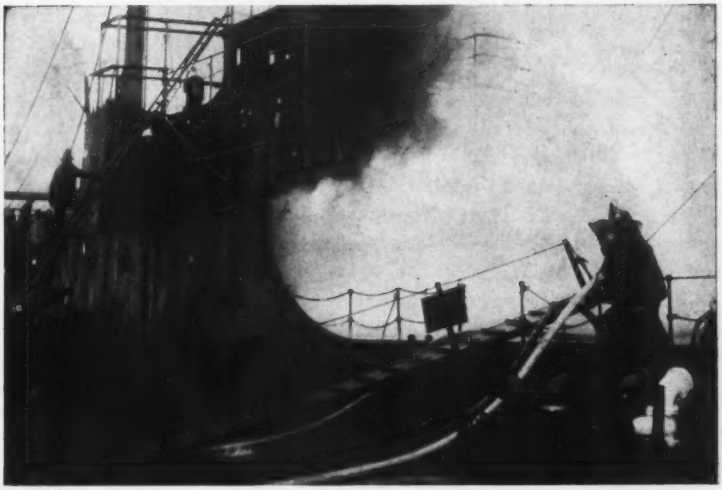
It is with the fatal building fire that the fire officer, builder and engineer are most concerned. As in the case of the conflagration hazard, the prevailing type of construction in a city and certain other local conditions determine the degree of danger to the lives of its citizens from fire. A brief description will therefore be given of San Francisco and those factors having a bearing on the frequency of its fatal fires.

The city of San Francisco covers an area of 46.5 square miles at the end of a hilly peninsula projecting into the Bay of San Francisco and bordering the Pacific Ocean on the west. It has a moderate climate, temperatures seldom reaching freezing. Frequent winds have little influence on the safety to life hazard. Its population was 634,394 in 1930 and estimated at 682,900 in 1937.

Principal Industries.

By reason of its location and superb harbor San Francisco was long the principal trade and shipping center of the Pacific Coast. At one time it was also a large manufacturing city. While still an important distributing point it has in the last few years lost considerable of its shipping, and much of its manufacturing has been diverted elsewhere. However, it continues to be the leading financial and insurance city of the West. Large scale hazardous manufacturing processes are few. Principal industries are ship-building, canning, coffee processing, printing, slaughtering and meat packing, and lumber mills. Several oil companies maintain storage facilities along the water front. Concrete docks with long unsprinklered wooden sheds extend for nearly four miles along the bay. There have been two fatal fires, each involving four men, on the waterfront in recent years. Few manufacturing plants have a large number of employees and the fatal fire loss record in them is good.

The newer schools are all of fire-resistive construction. Under the direction of the fire department fire drills are held monthly in all public schools. Even though until recent years most of them were old-fashioned 3- and 4-story



International.

Firemen extinguishing a fire on a gasoline tanker in San Francisco. Three of the crew were burned to death and a spectator was killed in jumping from the pier. (Reported in January, 1932, QUARTERLY, page 299.)

wood structures, no death by fire in any of these schools has been reported for 30 years. Nearly all public buildings are of modern materials and design. Probably the most dangerous of the municipally owned buildings are some old wooden fire houses. There are 78 theatres, of which 38 have a seating capacity of over one thousand, the largest accommodating 4650 people. Their construction is for the most part good, even though they were designed under the existing antiquated building code, the exit requirements of which, particularly as applied to large places of public assembly, are poor and not in accordance with present laws elsewhere.

Probably nearly 90% of the built-on area is covered by wooden construction, mostly two-, three-, and four-story frame. The business section is at the northeasterly corner of the city. Between it and the main residential areas is the apartment house and hotel district in which a large majority of the buildings are of wood joisted and masonry walls construction. The remainder, about 25%, are fire-resistive.

City Building Code.

The city building code in effect during the period of this record limits the height of wooden buildings to 40 feet or three stories and basement, and masonry buildings with interior wood framing to 84 feet when metal lath and plaster is used, and to 55 feet if lath is wood. However, a state law places a limit of three stories and basement on frame buildings, and six stories and

basement for masonry when used for living purposes. The definition of "basement" is such that the floor thereof may be practically at grade level so that, in actual practice, there is no true basement at all, but a four-story building of which the street floor is used as a garage for tenants. Only three stories may be legally occupied for living purposes. Such buildings are becoming very numerous. There is no height limit to steel frame construction, but reinforced concrete may not exceed ten stories. Wooden buildings are not permitted within the fire limits. There are, however, numerous wooden apartments and some wooden hotel buildings, several of considerable area, which were built previous to the code and which are five and even six stories in height.

The state law requires the enclosure of elevator shafts but not of stairs in hotels and apartments, but in many of the older buildings neither is enclosed. Small interior shafts are frequently encountered. Neither sprinklers nor fire

Table No. 1—Fires and Deaths — 20 Years.

Year	No. of Fires	Lives Lost. Men	Women	Children	Total
1918	21	8	9	7	24
1919	16	5	8	3	16
1920	14	5	9	2	16
1921	11	3	7	1	11
1922	12	1	8	3	12
1923	12	4	5	3	12
1924	17	7	5	5	17
1925	17	5	6	6	17
1926	10	5	4	1	10
1927	17	18	4	3	25
1928	16	11	5	3	19
1929	10	3	4	3	10
1930	18	5	4	9	18
1931	20	19	4	4	27
1932	17	8	6	3	17
1933	17	18	5	2	25
1934	15	9	4	2	15
1935	18	11	7	1	19
1936	22	17	10	5	32
1937	18	12	4	3	19
Total	318	174	118	69	361
Per Cent	100	48.0	32.6	19.4	100

Fatal Fires by Number of Lives Lost.

Lives Lost per Fire	1918-1922	1923-1927	1928-1932	1933-1937	Total	Per Cent
1	70	70	77	81	298	93.8
2	3	1	1	5	10	3.1
3	1	..	..	1	2	.6
4	..	1	3	1	5	1.6
5	..	1	..	1	2	.6
6	..	..	..	..	..	..
7	..	..	..	1	1	.3
Total	74	73	81	90	318	100.0

Table No. 2 — Lives Lost per Fire and Fatal Fires per Capita.

Year	No. of Fires	Lives Lost	Lives Lost per Fire	Average Annual Fatalities per 100,000 Pop. Fires	Lives Lost
1918-1922	74	79	1.07	2.9	3.1
1923-1927	73	81	1.11	2.6	2.8
1928-1932	81	91	1.12	2.6	2.9
1933-1937	90	110	1.23	2.7	3.3
20 Years	318	361	1.13	2.7	3.0

alarms are required in any part of these buildings, the majority of which are a distinct life hazard. To offset inferior construction and lack of proper exit facilities the use of exterior fire escapes of the inclined ladder type is very general. The latter are exposed to flame from window openings and rarely reach to the ground. Though required by law to have drop ladders from the lowest balcony to the ground, only a small percentage comply.

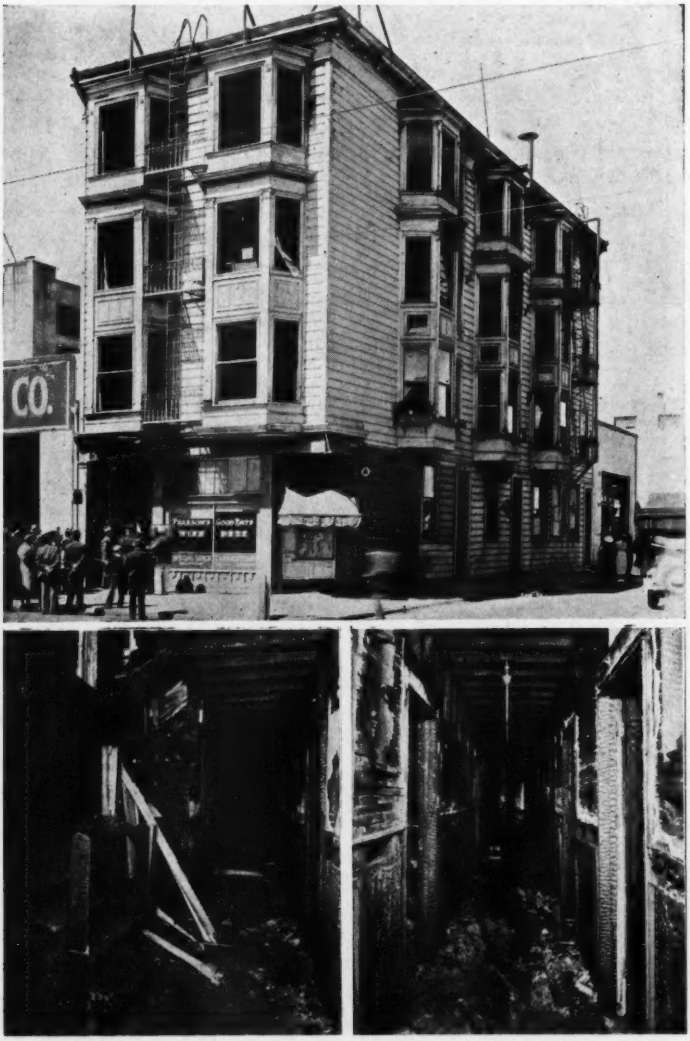
Fire Prevention Bureau.

Next in importance to building construction in affecting safety of life from fire is maintenance. It controls the access to exits (locking or obstructing) as well as good housekeeping, which includes conditions causing both the ignition and spread of fires. Maintenance can be enforced by municipal fire prevention authorities. The first Fire Prevention Bureau in San Francisco was formed in 1920. It was pretty much of a skeleton organization until a new ordinance was passed in 1930, which enlarged its scope and personnel. It now has 21 members, including those assigned to arson investigation. Fire laws are incomplete, conflicting, and badly in need of revision.

Until the last few years inspections were reasonably frequent and effective. Enforcement, however, has been poor, especially in apartment and lodging houses, and hotels, where the greatest life hazards exist.

These buildings, because of their construction and the fact that a large part of the population sleeps in them, constitute, by far, the most dangerous fire menace to life. Because none are improving with age, many of them which were not safe when new are now less safe. The dangers in them are not diminishing, but as their social scale declines so does maintenance, while congestion and the fire hazard increase.

As injuries and fatalities to building occupants usually take place at the earlier stages of a fire, promptness of arrival of the fire department is a factor in reducing the extent of the life loss only in larger fires. Public fire alarm boxes are closely spaced. Transmission of signals and response of the apparatus is very rapid in San Francisco. Traffic accidents to fire equipment, however, have been frequent. During the time covered by this record traffic regulation has improved from poor to fair. Not less than six firemen were killed while responding to alarms, and many were seriously injured. These deaths are considered as automobile accidents and are not entered in the tables.



In this frame tenement seven persons lost their lives in an early morning fire. Although damage to the outside of the building was slight, the fire spread rapidly up stairways and corridors without cut-offs and involved the whole interior of the building in a very few minutes. Fire escapes, which terminated at the second floor and were not protected from flame issuing from windows, were utterly worthless as emergency exits.

Although a fire department may play an important rôle in rescue work, neither its size nor efficiency can remove the danger to life created by defective construction. Two of the worst fires herein recorded occurred within two blocks of fire stations.

Definition of Fatal Fires.

Before analyzing the statistics in the accompanying tables, it will be well to explain what fires have been entered as fatal fires and which were excluded. Most vital statistics classify fatalities by the direct cause of death, but for the purpose of fire data all deaths resulting from the occurrence of a fire are considered fatal fires, provided that the fire was the primary cause of the injury instead of the fire following some prior occurrence. Thus a person jumping from a burning building, though killed by the fall, would here be classified as a fire fatality, whereas if after an automobile crash the vehicle caught fire and the occupants were burned to death, the occurrence would be classified as an automobile accident. However, if through careless smoking or for some other reason an automobile caught fire and then crashed, it would be listed as a fatal fire. Suicides by fires are excluded. In 1920 there was an airplane accident and two automobile accidents in San Francisco, in each of which three people were burned to death. None of these are entered in the tables. One fire in an automobile is included. In this case the fire department had been summoned to extinguish a fire in an automobile on the street. Apparently a revolver had been left on the seat. The heat of the fire exploded a cartridge, the bullet killing the captain of the fire company.

Although in this article fatal fires are divided into two main groups, those of self-ignition and those in burning structures, a third type should be mentioned, namely fatalities caused by panics. Though now rare in this country, they often account for the heaviest losses. During the time of this record there were several fires in San Francisco theatres while an audience was present, but no panics resulted. This is probably due to a change in the public state of mind throughout the country. The public now has confidence in the safety of theatres and other buildings of public assembly. The sight of fire no longer grips people with terror, whereas in the past the mere cry of "fire" was sufficient to create a stampede. Panic is a reaction to fear which is not necessarily based on real danger.

The statistics presented in the tables are from the writer's records, supplemented by those of the city coroner. Although no data are available showing the relationship between the property loss and the number of fatal fires, nor between fatal fires and the total number of fires in a community, there can be little doubt that the conditions which bring about a reduction in the fire waste must also similarly affect fatal fires. It is therefore interesting to note in Table No. 2, which is divided into four five-year summaries, that, in San Francisco, fatal fires have been increasing during the past ten years, although

Table No. 3 — Occupancy in Which Loss of Life Occurred.

Class of Fire	1918-1922 Fires	1918-1922 Deaths	1923-1927 Fires	1923-1927 Deaths	1928-1932 Fires	1928-1932 Deaths	1933-1937 Fires	1933-1937 Deaths	Total Fires	Total Deaths
Dwellings										
Private houses	58	60	49	49	47	48	45	50	199	207
Apartments	1	2	5	6	8	8	18	24	32	40
Hotels	1	1	2	2	3	3	5	5	11	11
Lodging houses	2	2	5	9	6	9	9	15	22	35
Public Buildings										
Churches	1	1	..	..	1	1	..	..	2	2
Hospitals	1	1	1	1	..	..	..	..	2	2
Relief home	..	..	2	2	..	..	..	..	2	2
Car barn	..	..	..	..	1	1	..	..	1	1
Mercantile										
Garage	..	..	2	5	1	1	..	..	3	6
Night club	..	..	..	..	..	..	1	4	1	4
Stores	..	..	..	..	..	..	3	3	3	3
Paint warehouse	1	1	..	..	..	..	..	..	1	1
Restaurant	..	..	..	..	1	1	..	..	1	1
Electric power	..	..	..	..	1	1	..	..	1	1
Plumbing shop	..	..	..	..	..	..	1	1	1	1
Vulcanizing shop	..	..	..	..	..	..	1	1	1	1
Gas station	..	..	..	..	..	..	1	1	1	1
Manufacturing										
Fireworks	1	3	..	..	..	..	..	..	1	3
Printing	1	1	1	1	..	..	..	..	2	2
Factories	1	1	1	1	1	1	..	..	3	3
Carpenter shop	..	..	1	1	..	..	..	..	1	1
Packing plant	..	..	1	1	..	..	..	..	1	1
Smelting	..	..	1	1	..	..	..	..	1	1
Ship building	..	..	1	1	..	..	..	..	1	1
Hangar	..	..	..	..	1	1	..	..	1	1
Winery	..	..	..	..	..	..	1	1	1	1
Outside of Buildings										
Ships and piers	..	..	..	..	2	8	..	..	2	8
Street	2	2	..	..	4	4	..	..	6	6
Vacant lot	..	..	1	1	1	1	..	..	2	2
Paving plant	..	..	..	..	..	..	2	2	2	2
Lumber yard	..	..	..	..	..	..	2	2	2	2
Domestic yard	..	..	..	..	1	1	..	..	1	1
Automobile	..	..	..	..	1	1	..	..	1	1
Tank car	..	..	..	..	..	..	1	1	1	1
Unknown	4	4	..	..	1	1	..	..	5	5
Total	74	79	73	81	81	91	90	110	318	361

Percentage by Groups — 20 Years.

	Fires No.	Fires %	Deaths No.	Deaths %		Fires No.	Fires %	Deaths No.	Deaths %
Dwellings	264	83.0	293	81.1	Manufacturing	12	3.8	14	3.9
Public buildings	7	2.2	7	1.9	Out of doors	17	5.3	23	6.4
Mercantile	13	4.1	19	5.3	Unknown	5	1.6	5	1.4
					Total	318	100.0	361	100.0

fire losses have been declining in other large cities. Also that the fatalities in this city in the last decade have increased at a greater rate than the population.

In order to arrive at intelligent deductions from a study of the data in the tables, the fires caused by the victims setting their clothing or bedding on fire by some act of their own, and herein termed "self-ignition," should be examined separately from those resulting from other causes. They are tabulated in the first part of Table No. 4. These fatalities are practically all due to carelessness and can be reduced only through the process of education. They have no relation to building laws and only to a certain extent to fire prevention measures.

In the second part of Table No. 4 are classified the principal conditions which were the cause of the loss of life in burning buildings rather than the origin of the fire. Where it was not possible to determine conclusively the reason why a person did not escape from a burning building, the death is included under the heading "Trapped."

Gasoline was the cause of nearly all deaths from flammable liquids. Examples include lighting a match while draining the gasoline tank of an automobile, the ignition of vapors of gasoline flowing in a street gutter, breaking of a hose through which gasoline was being pumped, allowing it to flow on the deck of a ship, explosion of an oil tank due to defective construction and overheating.

"Indirect causes" are all other than suffocation and burns, and include both shock and heart failure.

Analysis of the Statistics.

An examination of the data in the tables shows the following interesting facts:

That in a period of 20 years over half of all fatalities were caused by some direct act of the victim, usually carelessness.

Eighty-three per cent of the fires occurred in buildings in which the victims lived and in which 79.7 per cent lost their lives.

Faulty construction was the greatest single cause of loss of life.

The number of fatal fires in proportion to population has remained practically constant for the past 15 years, but fire fatalities per capita and the number of larger fatal fires in San Francisco are increasing.

Of those killed, nearly one-half were men, nearly one-third women, and nearly one-fifth children.

There was not a single loss of life by fire or panic in a theatre or other large place of public assembly. (The two deaths in church fires were from fire fighting.)

Ten times as many people burned themselves to death in homes as in all other places combined.

Fires causing two or more deaths, unless resulting from explosions or panics, usually indicate that the victims were unable to escape from a burning structure. Of the 20 fires in which two or more persons perished, all but five, or 75 per cent, were in buildings in which they made their homes.

In the second ten-year period there were twice as many fires and deaths in lodging houses as for the first ten years. In hotels they both increased nearly three times, and in apartment buildings both fires and number of lives lost were four times greater in the last decade.

Of the sixteen buildings in which two or more persons succumbed, eleven were wood, four of masonry walls and wood joist interior construction, and one was of reinforced concrete.

Six firemen were killed in the performance of their duties. (This does not include those killed in responding to alarms.)

When natural gas replaced manufactured gas in 1930, an increase in explosions and gas fires immediately followed. In the 12 years prior to 1930 there were but two deaths from gas explosions. In the next eight years 17 deaths occurred from the same cause.

The increase in the use of tobacco since women have become smokers is indicated by the figures showing that in the first 10 years 10 lives were lost by smokers igniting their bedding or clothing, while the number more than doubled, to 23, in the last 10-year period.

Since September, 1921, San Francisco has had an ordinance prohibiting the sale of fireworks. Its beneficial effects are proved by the fact that in 20 years only three children were killed by playing with firecrackers. (In the fire of 1918, where three boys were killed, they had trespassed on a fireworks factory and there lighted matches, causing an explosion.)

Matches, especially in the hands of children, continue to be one of the principal causes of self-ignition.

The great extent that electric lights have replaced candles on Christmas trees explains the diminishing number of fatal fires from both the trees and candles.

Only one-half of those losing their lives in fighting fires were firemen.

Prohibition introduced a new hazard, the illicit liquor still, which took a toll of 11 lives.

It is important to note that even if all the cases of self-ignition be deducted from the figures tabulated, it will still be found that more than two-thirds (71¾%) of all the fatal fires occurred in buildings in which the victims lived.

In buildings used for dwelling purposes in which more than two were killed, open stairs were the principal contributing factor to the loss. They not only aided the spread of fire, but eliminated themselves as a means of egress.

Larger Fires.

From 1918 to 1937 there were 10 fires in which three or more people lost their lives and of which a brief description follows:

1918, JULY 3. Three boys, while trespassing in a fireworks factory, dropped a lighted match, which caused an explosion, killing them and wrecking a portion of the building.

Table No. 4 — Fatalities by Cause.

Self-Ignition.

Cause of Loss of Life	1918-1922	1923-1927	1928-1932	1933-1937	Total No.	Total %
Carelessness with matches (including playing with fire)	6	8	13	7	34	18.5
Smoking in bed	3	7	7	16	33	17.9
Clothing ignited from heater or stove	8	6	8	8	30	16.3
Fireplace or open grate	6	2	3	5	16	8.7
Home dry cleaning	1	4	3	3	11	6.0
Candle (except on Christmas tree)	5	1	3	..	9	4.9
Upsetting heater, stove or lamp	3	3	1	2	9	4.9
Starting fire with gasoline or kerosene	1	1	2	3	7	3.8
Hunting gas leak with open flame	..	..	3	4	7	3.8
Christmas tree	2	1	..	..	3	1.6
Lighting firecrackers	1	..	2	..	3	1.6
Bedding ignited by electric pad or light bulb	1	..	..	2	3	1.6
Carelessness with oil stove or lantern	2	..	..	..	2	1.1
Electric spark or arc	..	..	2	..	2	1.1
Alcohol	..	1	..	1	2	1.1
Kerosene and gasoline fires, miscellaneous	..	..	..	2	2	1.1
Electric heater	..	..	1	..	1	.5
Cause of self-ignition uncertain	7	2	..	1	10	5.5
Total	46	36	48	54	184	100.0

Building and Out-of-Doors Fires.

Cause of Loss of Life	1918-1922	1923-1927	1928-1932	1933-1937	Total No.	Total %
Lack of exits or faulty construction	1	6	5	19	31	17.5
Flammable liquid fires	5	8	12	5	30	16.9
Trapped (unknown reason)	5	11	1	7	24	13.6
Gas fires and explosions	1	..	7	4	12	6.8
Suffocation	2	1	4	5	12	6.8
Illicit stills	..	4	3	4	11	6.2
Intentional delayed escape, or re-entering burning building	1	4	..	2	7	4.0
Fire fighting—civilians	3	..	2	2	7	4.0
Fire fighting—firemen	1	2	3	..	6	3.4
Kerosene stove explosions	3	1	1	..	5	2.8
Waste basket or other small fire ignited clothing	2	1	..	..	3	1.7
Fireworks	3	..	..	..	3	1.7
Indirect causes	..	1	..	1	2	1.1
Powder explosion	..	1	..	..	1	.6
Outside of buildings						
Rubbish fires	1	1	1	..	3	1.7
Bonfires	..	..	2	..	2	1.1
Unknown	5	4	2	7	18	10.1
Total	33	45	43	56	177	100.0

International.

A torch dancer set fire to the cloth decorated ceiling of this second floor San Francisco night club. The only exit is shown behind the pile of débris on the right. Four persons lost their lives.

1927, Oct. 9. In addition to lacking proper exits, a three-story frame lodging house was built in an extremely flimsy manner. A night fire spread so rapidly that an engine and truck company located but two blocks away could not prevent five men from being burned to death.

1927, Oct. 12. The exact cause of this fire has never been determined, but apparently four men were in a small locker room of an automobile sales and repair firm and still wore their oil and grease soaked clothing. These caught fire when a spark ignited flammable vapor and the four were burned to death.

1928, Sept. 6. Painters were applying asphalt to piles underneath a pier by a process which involved a blow torch. Considerable tar or asphalt was said to have floated on the water and is believed to have been ignited by burning kerosene leaking from the blow torch. The men were on rafts and unable to escape. Four were killed and about 10 were injured.

1931, Oct. 10. About 4 o'clock in the morning a fire of undetermined origin started in the lobby of a four-story and basement wood-joisted concrete hotel. Although the one elevator was enclosed, the adjoining stairs were open, permitting fire and smoke to fill all halls, thereby making the usual means of egress inaccessible and also cutting off approach to some of the fire escapes. Sufficient heat spread through the light wells to cause the metal linings to drop off. Two men were burned to death in their rooms, one on a fire escape, and a fourth was suffocated in a hallway. The heavy loss of life and property damage can be attributed directly to the open stair. The nearest engine company was stationed only about 450 ft. away.

1931, Nov. 20. Shortly before noon an oil tanker was pumping gasoline into tanks on shore. The hose to shore manifold is supposed to have burst,

causing the liquid to flow on the deck of the ship. It was ignited from some unknown cause and small explosions followed. Three of the crew were burned to death. A spectator, in jumping from the pier, struck his head and later died. (QUARTERLY, Vol. 25, No. 3.)

1933, JAN. 4. A fire of unknown origin started at about 5 A.M. on the second floor of a four-story and basement brick apartment house. There was one hallway running the length of the building, near the front end of which was one enclosed elevator and an open stairway adjoining. Another narrow stair towards the rear was also open. Both stairs were built of wood and were open their entire length. At no time could they be used as a means of egress. In fact they were directly responsible for the rapidity with which the fire communicated from floor to floor. They not only acted as flues, but added fuel to the fire. The fact that the building was equipped with five fire escapes and that an engine and truck company were located three blocks away did not prevent the loss of five lives. There is little doubt that some of the occupants were intoxicated at the time of the fire, which may have contributed to the size of the loss, but had the building been equipped with a reliable automatic fire alarm probably all could have been saved.

1933, APRIL 10. When the operator of a still in the basement of a four-story wooden apartment building turned on an electric switch the fumes ignited, setting his clothing on fire. He was burned to death. The explosion also set fire to the building. Flames traveled through a central open stairway to all floors. Two tenants died in their rooms.

1936, MAY 13. During a performance in a night club on the upper floor of a two-story wood joist, brick building a dancer, carrying a benzine torch, ignited the cloth decorated ceiling. A flash fire followed. About 60 people are said to have been in the main room or dance floor. There was but one exit, a stairway leading to the street. The windows had been boarded over as part of the decorative scheme. All deaths were attributed to suffocation from carbon monoxide or other toxic gases. The rapidity of the fire in so small an area probably created a short high temperature and exhausted much of the oxygen. Two men and two women lost their lives.

1936, JUNE 7. Fire started at the base of the main stairs of an old four-story wooden lodging house about 25 ft. by 75 ft. At the time of the discovery of the fire, about 3:25 A.M., the entire stairway was involved. At the bottom of a narrow rear stair, which extended above the second floor only, two men were found dead. The building was of highly flammable construction. Although it was on a corner, giving good access for rescue work, and had two exterior fire escapes, of which one was of the straight ladder type and the other inclined, but both of which terminated at the second floor, seven persons lost their lives.

Comparison with New York and Los Angeles.

It will be seen from Table No. 5 that the per capita life loss in San Francisco is nearly twice that in New York and Los Angeles. There is considerable divergence between the California cities and New York in the ratios of men, women and children, but in both New York and San Francisco the majority of deaths from fire take place in the home. The data on New York and Los

Angeles were taken from the annual reports of their fire departments. Occupancy data from Los Angeles were not available.

Table No. 5.

Five-Year Average Annual Loss of Life from Fires, 1933 to 1937.

	Lives Lost	Deaths per 100,000 Population	Per Cent			Per Cent	
			Men	Women	Children	Dwellings*	Other Buildings
New York	125	1.72	43.0	37.5	19.5	78.8	21.2
Los Angeles	24	1.67	61.0	28.8	10.2	...	...
San Francisco	22	3.3	61.0	27.2	11.8	85.5	14.5

Experience in San Francisco, as indicated by the fires described above, confirms that of other cities. It shows that no amount of fire escapes on the outside of a building, or fire department operations, can entirely offset the deficiencies of construction on the inside, and that the lives of people sleeping in buildings over three stories in height in which the vertical openings are unprotected cannot be considered safe. This statement applies even to fire-resistive buildings, for the dangers of faulty design are not limited to wood. Three years ago fire broke out about five o'clock in the morning in a thirteen-story hotel in San Francisco in which all stair and elevator shafts were open. Though the fire started on a lower story, the heat and smoke became so intense on the top floors that the principal exits could be located with difficulty and several persons were overcome, a few barely escaping alive. The smoke and toxic gases which fire produces are as dangerous to life as the flame itself.

This fire record of twenty years shows that, except in buildings used for living purposes, there has not been a sufficient number of fatal fires in any single occupancy to indicate any unusual life hazard, but that there is ample cause for concern for those who live in the multiple dwelling buildings. It is impossible to make safe the old wooden apartment and lodging houses erected during the few years following the conflagration of 1906. They should be removed. The life hazards in the large number of apartment and hotel buildings constructed under, and some in violation of, the present law can largely be removed by structural changes, such as the enclosure of vertical openings. In some this is impractical or prohibitive in cost. The remedy in such buildings can be found in the installation of properly supervised sprinklers or automatic alarm systems so that the occupants may be warned of a fire at its inception rather than when it has reached such size that not all can escape uninjured.

The existing conditions in San Francisco are largely inherited from errors of construction in the past, are partly perpetuated by an obsolete building code, and are permitted to grow worse by the absence of effort to correct them. It remains to be seen whether the danger spots will be removed by fire or by the insistence of the citizens.

*Includes all kinds of buildings used for dwelling purposes, both permanent and transient.